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ISO/TC 183/WG 3A - DETERMINATION OF COPPER IN COPPER CONCENTRATES - TITRIMETRIC METHODS STATISTICAL EVALUATION OF INTERNATIONAL TEST DATA 1984-1986

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Analytical Methodology

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ISO/TC 183/WG 3A - DETERMINATION OF COPPER IN COPPER CONCENTRATES - TITRIMETRIC METHODS STATISTICAL EVALUATION OF INTERNATIONAL TEST DATA 1984-1986

by

R. Sutarno* and W.S. Bowman**

SUMMARY

The analytical data resulting from the international test on the determination of Cu in copper concentrates by both long and short iodide titrimetric methods, conducted by ISO/TC 183/WG 3A have been statistically evaluated to estimate the precision. Based on these analytical results the preliminary estimate of the precision can be expressed in terms of concentration of copper in the sample by the following equations.

Long Iodide Method	Short Iodide Method
$r = 0.0026\ X + 0.0850$	$r = 0.0049\ X + 0.0464$
$P = 0.0112\ X + 0.0788$	$P = 0.0189\ X - 0.0383$
$\sigma_T = 0.0009\ X + 0.0300$	$\sigma_T = 0.0017\ X + 0.0164$
$\sigma_L = 0.0039\ X + 0.0228$	$\sigma_L = 0.0066\ X - 0.0171$

when X is the Cu concentration in the sample, r is the repeatability, P is the permissible tolerance, σ_T is the within-laboratory standard deviation and σ_L is the between-laboratories standard deviation; all in mass %. Analytical results of five samples containing Cu ranging from 20 to 50% were used for computing there regression lines.

Comparison of the analytical results obtained by both methods shows that both produced results with equal accuracy. The long iodide method is slightly more precise than the short iodide method.

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ISO/CT 183/WG 3A - DÉTERMINATION DU CUIVRE DANS LES CONCENTRÉS DE CUIVRE PROCÉDÉS TITRIMÉTRIQUES ÉVALUATION DES DONNÉES PROVENANT D'UN ESSAI À L'ÉCHELLE INTERNATIONALE AU MOYEN DU TRAITEMENT STATISTIQUE DES RÉSULTATS ANALYTIQUES (1984-1986)

par

R. Sutarno* et W.S. Bowman**

RÉSUMÉ

Les résultats analytiques d'un essai mené à l'échelle internationale par ISO/CT 183/WG 3A en vue de déterminer la teneur en cuivre des concentrés de cuivre par des méthodes titrimétriques à l'iodure de courte et de longue durée ont été évalués à l'aide du traitement statistique des résultats analytiques. En se fondant sur ces résultats, l'évaluation préliminaire de l'exactitude des mlthodes en fonction de la concentration de cuivre dans l'échantillon peut être exprimée par les équations suivantes.

Essai prolongé à l'iodure	Essai de courte durée à l'iodure
$r = 0.0026\ X + 0.0850$	$r = 0.0049\ X + 0.0464$
$P = 0.0112\ X + 0.0788$	$P = 0.0189\ X - 0.0383$
$\sigma_r = 0.0009\ X + 0.0300$	$\sigma_r = 0.0017\ X + 0.0164$
$\sigma_L = 0.0039\ X + 0.0228$	$\sigma_L = 0.0066\ X - 0.0171$

où X représente la concentration de cuivre dans l'échantillon, r égale la répétabilité, P est l'écart admissible, σ_r est l'écart-type intralaboratoire et σ_L est l'écart-type interlaboratoire: tous en pourcentage massique. Les résultats analytiques de cinq échantillons dont la teneur en cuivre variait entre 20 et 50 % ont été utilisés pour calculer la régression linéaire.

La comparaison des résultats analytiques obtenus au moyen des deux méthodes démontre que celles-ci ont un même degré de précision. Le degré de précision de l'essai prolongé à l'iodure est quelque peu plus élevé que celui de l'essai de courte durée.

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INTRODUCTION

The analytical data were collected by the convener of ISO/TC 183/WG 3A (Technical Committee 183 - Copper, lead and zinc ores and concentrates, Working Group 3A - Copper in copper concentrates) from an international test conducted during the period of 1984-1986. Two analytical methods, (1) long iodide method and (2) short iodide method, were tested. Six samples of copper concentrates with copper contents ranging from 20 to 50% were used. Twenty-five laboratories provided analytical data; most of them analysed five samples using both methods. Only few laboratories analysed sample No. 10, consequently the results obtained from this sample were not used to estimate the precision of the methods.

The purpose of this statistical evaluation is to provide the working group with preliminary estimates of the precision of the analytical methods in the form of repeatability, permissible tolerance, within-laboratory and between-laboratory standard deviations.

PRINCIPLES OF THE ANALYTICAL METHODS

1. Long iodide method (1)

Decomposition of the sample in nitric and sulphuric acids. Precipitation of copper sulphide with sodium thiosulphate, filtration and dissolution of the precipitate in nitric, sulphuric acids.

Titrimetric determination of copper by addition of excess potassium iodide and titration the liberated iodine using standard sodium thiosulphate solution.

Traces of copper in the sulphide filtrate and filter paper are determined by flame - AAS (atomic absorption spectrometric method) and added to the titrimetric results.

2. Short iodide method (2)

Decomposition of the concentrate in a sulphuric acid/nitric acid mixture.

Addition of ammonium hydrogen difluoride followed by an excess potassium iodide and titration with sodium thiosulphate in the presence of soluble starch indicator.

PROCEDURE OF EVALUATION

The analytical data were statistically evaluated by the procedure described in document ISO/TC 102/TCR 5 (3). Because each participating laboratory analysed only one bottle of each sample, as required by WG stage A, the two-way analysis of variance (ANOVA) part of the procedure was bypassed. No confirmation of sample homogeneity was made; thus the between-laboratory variance may include, if any, the between-bottles variation of the sample. This procedure is illustrated schematically in Figure 1.

The raw data and the detailed calculations are presented in Appendix A. They are summarized in Tables 1 and 2. The raw data are also plotted in Figure 2. The boxed points in these figures signify that the data were suspected outliers and were excluded from the estimation of the sample means and the precisions. The letters C and D on the boxed data signifies that these data were suspected to be outliers due to poor precision (Cochran's test) or due to the deviation from the sample means (Dixon's test), respectively.

The precisions estimated (σ_r, σ_L, r and P) are plotted against these corresponding sample means in Figure 3, and the regression equations of these precisions versus sample means were computed and presented in Table 1. These equations are expected to valid only within the experimental range i.e. from 20 to 50% Cu. Extrapolation of this range requires chemical justification.

OBSERVATIONS

An ideal standard analytical method is an analytical method that can be applied by any qualified analyst with proper equipment and reagents with equal high precision and accuracy. This implies that the better the method is standardized, the smaller the σ_L / σ_r ratio and the fewer the outliers. The magnitude of the within-laboratory standard deviation σ_r depends on the state of the art of the method and the user's requirement. Experience from other mineral analyses has shown that for a good method, the average σ_L / σ_r is found to be 2.

The results obtained fom both methods were compared. Table 3 shows the ratios of both sample overall means and precision; Table 4 the statistical comparison of the means and Table 5 the statistical comparison for the precision. There is no difference between the means obtained by the two methods. The long iodide method shows slightly better precision than the short method. This statistical comparison was done at significant level $\alpha = 0.05$.

REFERENCES

1. "Determination of copper in copper concentrates - Iodide Titrmetric Method"; First working draft, ISO/TC 183 (WG, A-6), 1985-05-06.

2. "Determination of copper in copper concentrate - Short Iodide Titrimetric Method"; First working draft, ISO/TC 183 (WG 3A-5), 1985-05-06.

3. "Procedure for statistical evaluation of analytical data resulting from international tests"; ISO/TC 102/TCR 5, 1985-06-11.

Abbreviations Used in this Report

σ_r = SIGMA-R - within laboratory standard deviation

σ_L = SIGMA-L - between laboratories standard deviation

r* = R - repeatability

= $2.83\ \sigma_r$

p** = permissible tolerance between laboratories

= $2.83\left(\sigma_L^2 + \sigma_r^2/2\right)^{\frac{1}{2}}$

* Repeatability, r, is the value below which the absolute difference between two independent single test (analysis) results produced by a laboratory on identical material using the same equipment within a short interval of time, using the standardized test method, may be expected to be with a 95% probability.

** Permissible tolerance between laboratories, P, is the value below which the absolute difference between two means of duplicate test results on identical material obtained by operators of different laboratories using the standardized test method, may be expected to lie with a 95% probability.

KO - total number of participating laboratories

K - number of sets of laboratory results used for ANOVA

NO - total number of analytical results

N - No. of analytical results used for ANOVA

Table 1.L

ISO/TC 183/WG 3A/WG 3A-6 COPPER IN COPPER CONC. LONG IODIDE METHOD

SUMMARY OF PRECISIONS FOR ALL SAMPLES

ELEMENT	SAMPLE	KO	K	NO	N	MEAN(X)	REPEATABILITY	PERMISSIBLE TOLERANCE	SIGMA-R	SIGMA-L	SIGMA-L/SIGMA-R
COPPER	85-6	25	24	74	71	19.7990	.1182	.3654	.04177	.12568	3.01
COPPER	85-7	25	24	74	71	24.1825	.1586	.4288	.05604	.14624	2.61
COPPER	85-8	25	23	74	69	33.3279	.2155	.2323	.07613	.06196	.81
COPPER	85-9	25	22	74	65	50.4165	.2032	.7342	.07179	.25443	3.54
COPPER	85-10A	21	19	62	56	28.6109	.1421	.3876	.05023	.13228	2.63

THE REGRESSION EQUATIONS ARE:

					CORR. COEFF.
R	=	.0026 X	+	.0850	.7617
P	=	.0112 X	+	.0788	.7156
SIGMA-R	=	.0009 X	+	.0300	.7617
SIGMA-L	=	.0039 X	+	.0228	.6588

Table 1.S

ISO/TC 183/WG 3A/WG 3A-5 COPPER IN COPPER CONC. SHORT IODIDE METHOD

SUMMARY OF PRECISIONS FOR ALL SAMPLES

ELEMENT	SAMPLE	KO	K	NO	N	MEAN(X)	REPEATABILITY	PERMISSIBLE TOLERANCE	SIGMA-R	SIGMA-L	SIGMA-L/SIGMA-R
COPPER	85-6	26	23	77	68	19.7961	.1409	.3601	.04965	.12229	2.46
COPPER	85-7	26	26	77	77	24.0909	.1901	.6691	.06717	.22944	3.42
COPPER	85-8	26	25	77	74	33.3506	.2095	.3334	.07401	.10554	1.43
COPPER	85-9	26	26	77	77	50.4075	.2958	1.0305	.10491	.35657	3.41
COPPER	85-10A	22	22	66	66	28.5963	.1552	.3713	.05485	.12535	2.29

THE REGRESSION EQUATIONS ARE:

					CORR. COEFF.
R	=	.0049 X	+	.0464	.9432
P	=	.0189 X	+	-.0383	.7468
SIGMA-R	=	.0017 X	+	.0164	.9432
SIGMA-L	=	.0066 X	+	-.0171	.7307

Table 2.L

ISO/TC 183/WG 3A/WG 3A-6 COPPER IN COPPER CONC. LONG IODIDE METHOD

LIST OF OUTLIERS

ELEMENT	SAMPLE	COCHRAN (PRECISION)	DIXON (ACCURACY)	LAB HAS ONLY ONE RESULT	INDIVIDUAL OUTLYING RESULT (DIXON)
COPPER	85-6	LAB 4	-	-	-
COPPER	85-7	LAB 9	-	-	-
COPPER	85-8	LAB26	LAB 3	-	-
		-	LAB26	-	-
COPPER	85-9	LAB17	LAB26	-	-
		LAB24	-	-	-
		LAB26	-	-	-
COPPER	85-10A	LAB24	-	-	-
		LAB26	-	-	-

Table 2.S

ISO/TC 183/WG 3A/WG 3A-5 COPPER IN COPPER CONC. SHORT IODIDE METHOD

LIST OF OUTLIERS

ELEMENT	SAMPLE	COCHRAN (PRECISION)	DIXON (ACCURACY)	LAB HAS ONLY ONE RESULT	INDIVIDUAL OUTLYING RESULT (DIXON)
COPPER	85-6	LAB 4 LAB19 LAB24	LAB19 LAB24 -	- - -	- - -
COPPER	85-7	-	-	-	-
COPPER	85-8	-	LAB26	-	-
COPPER	85-9	-	-	-	-
COPPER	85-10A	-	-	-	-

Table 3. Copper in Copper Concentrates;
Comparison of sample overall means and precision obtained by long and short iodide methods.

Sample No	$\bar{x}$ %*			r, %			P, %			σ_r, %			σ_L, %		
	L	S	L/S	L	S	L/S	L	S	L/S	L	S	L/S	L	S	L/S
85-6	19.799	19.796	1.00	0.118	0.140	0.84	0.365	0.365	1.01	0.042	0.050	0.84	0.126	0.122	1.03
85-7	24.182	24.090	1.00	0.159	0.190	0.84	0.429	0.663	0.65	0.056	0.067	0.84	0.146	0.229	0.64
85-8	33.328	33.352	1.00	0.215	0.209	1.03	0.232	0.333	0.70	0.076	0.074	1.03	0.062	0.106	0.58
85-9	50.416	50.407	1.00	0.203	0.296	0.69	0.734	1.030	0.71	0.072	0.105	0.69	0.254	0.356	0.71
85-10	28.581	28.561	1.00	0.111	0.088	1.26	0.966	1.024	0.94	0.039	0.031	1.26	0.340	0.361	0.94
85-10A	28.611	28.596	1.00	0.142	0.155	0.92	0.388	0.371	1.05	0.050	0.054	0.93	0.132	0.125	1.06

$\bar{x}$ - sample overall mean
L - Long iodide method
S - Short iodide method

Table 4. Copper in Copper Concentrates;
Statistical test for the difference between sample overall means obtained by long and short iodide methods.

Sample No°	$\bar{x}_L$	$\bar{x}_S$	$\lvert\bar{x}_L-\bar{x}_S\rvert$	$V[\bar{x}_L]_{x10^3}$	$V[\bar{x}_S]_{x10^3}$	s_d	T	
85-6	19.799	19.786	0.003	0.6857	0.6896	0.0371	6.08	I
85-7	24.182	24.090	0.092	0.9394	2.0918	0.0551	1.67	I
85-8	33.328	33.351	0.023	0.2509	0.5215	0.0278	0.82	I
85-9	50.416	50.408	0.008	3.0364	5.0525	0.0899	0.09	I
85-10	28.581	28.560	0.021	19.7068	22.1854	0.2067	0.10	I
85-10A	28.611	28.596	0.015	0.9713	0.7598	0.0416	0.36	I

$V[\bar{x}]$ - variance of the sample overall mean

$s_d = \left[V[\bar{x}_L] + V[\bar{x}_S]\right]^{\frac{1}{2}}$

$T = \dfrac{\lvert\bar{x}_L - \bar{x}_S\rvert}{s_d}$

I = There is no evidence that $\bar{x}_L$ is not equal to $\bar{x}_S$.

Table 5. Copper in Copper Concentrates;
Statistical test for the ratio of precision obtained by long and short iodide methods.

Sample No	Within Lab. σ_r^2						Between Lab. Mean Squares					
	L	f_L	S	f_S	L/S		L	f_L	S	f_S	L/S	
85-6	0.00174	47	0.00246	45	0.707	I	0.04846	23	0.04667	22	1.038	I
85-7	0.00314	47	0.00451	51	0.696	I	0.06640	23	0.16038	25	0.414	R
85-8	0.00580	46	0.00548	49	1.058	I	0.01731	22	0.03844	24	0.450	R
85-9	0.00515	43	0.01092	51	0.472	R	0.19637	21	0.38740	25	0.507	I
85-10	0.00155	11	0.00096	11	1.615	I	0.32821	5	0.36948	5	0.888	I
85-10A	0.00252	37	0.00301	44	0.837	I	0.05408	18	0.05015	21	1.078	I

f - degrees of freedom

I - there is no evidence that the precision of the long iodide method is not equal with that of the short iodide method.

R - there is evidence that the precision of the long iodide method is not equal with that of the short iodide method.

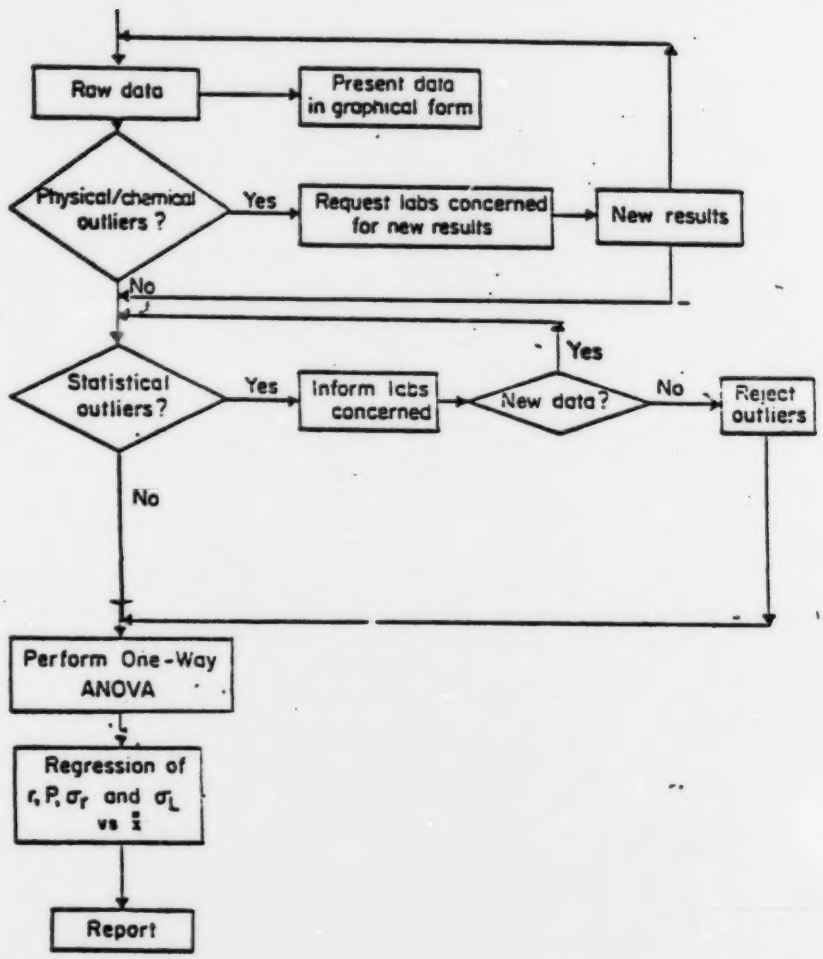
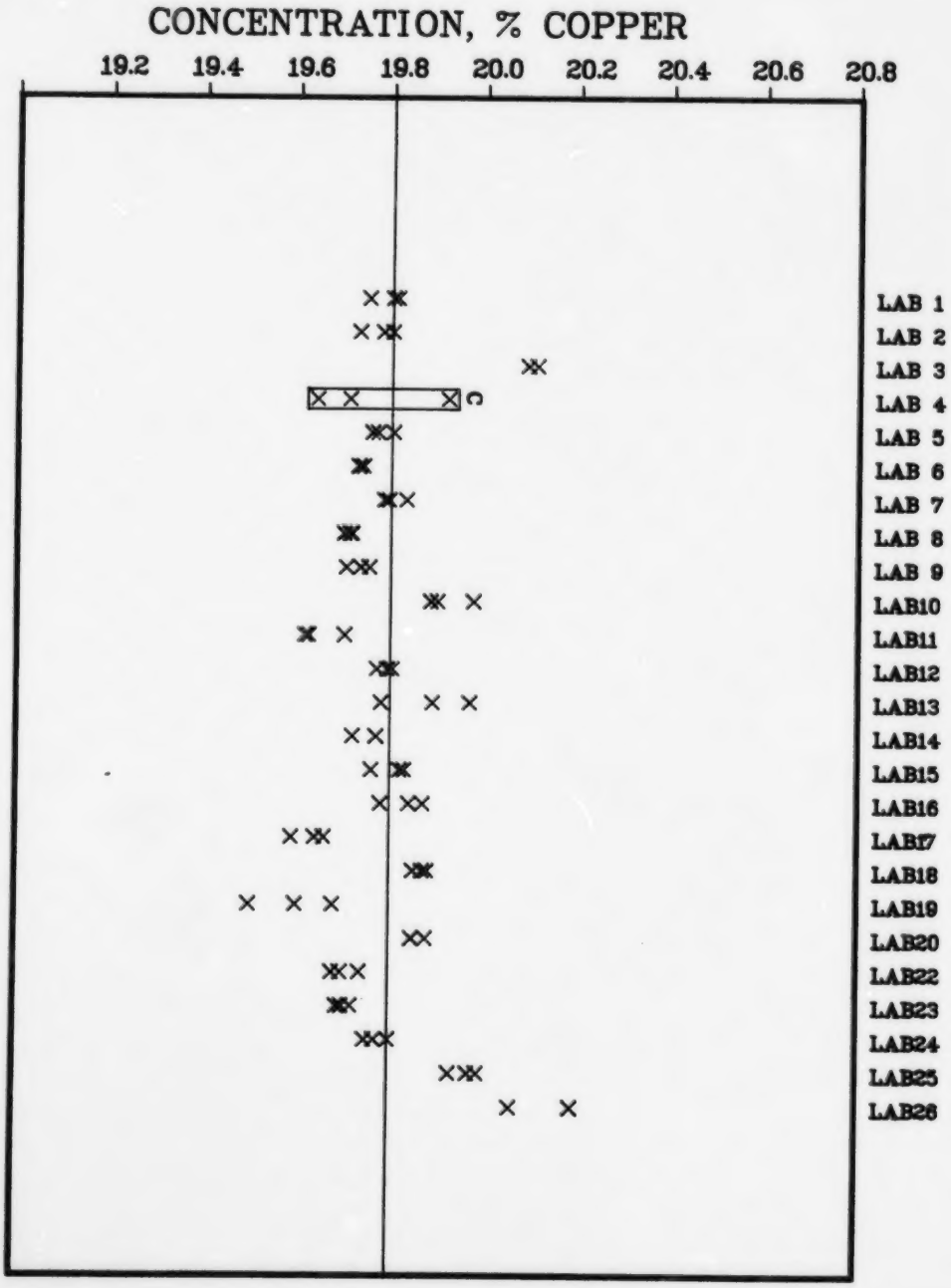
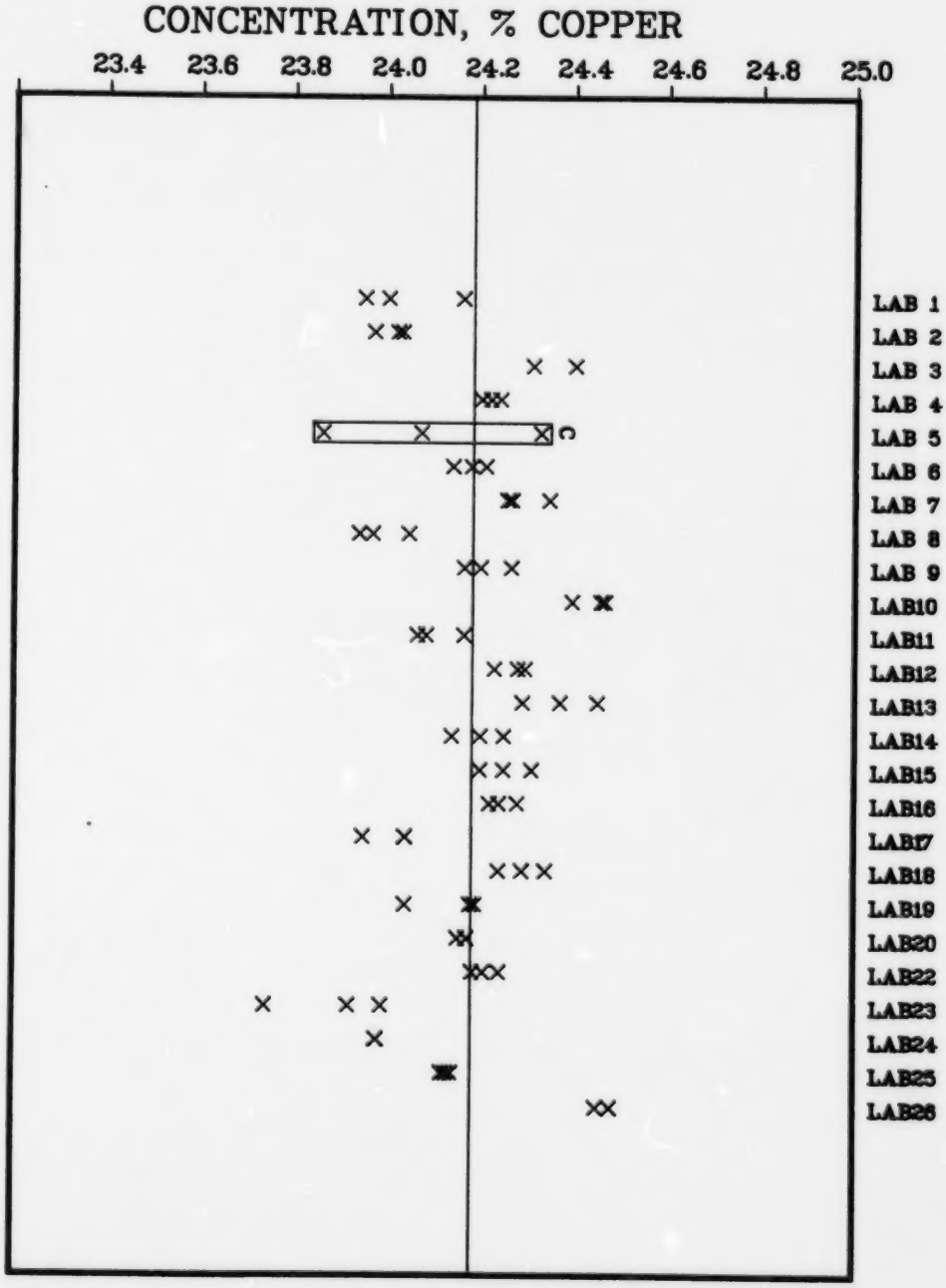


Figure 1. Flow Chart of the Procedure for Statistical Evaluation of Analytical Data Resulting from International Tests If The Test Sample is Known to be Homogeneous.



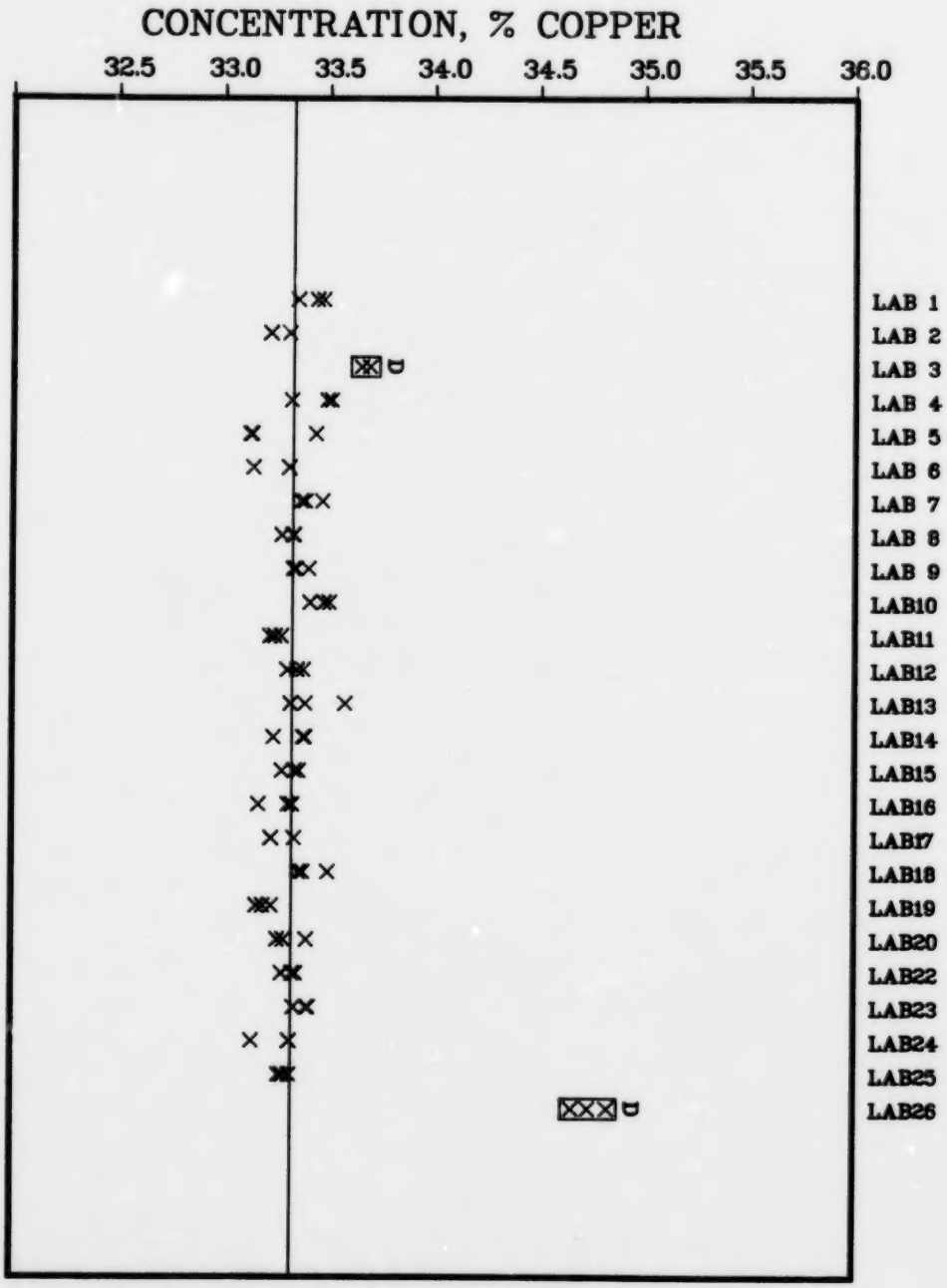
ISO/TC 183/WG 3A/WG 3A-6 COPPER IN COPPER CONC. LONG IODIDE METHOD
SAMPLE 85-6
Figure 2.L.1



ISO/TC 183/WG 3A/WG 3A-6 COPPER IN COPPER CONC. LONG IODIDE METHOD

SAMPLE 85-7

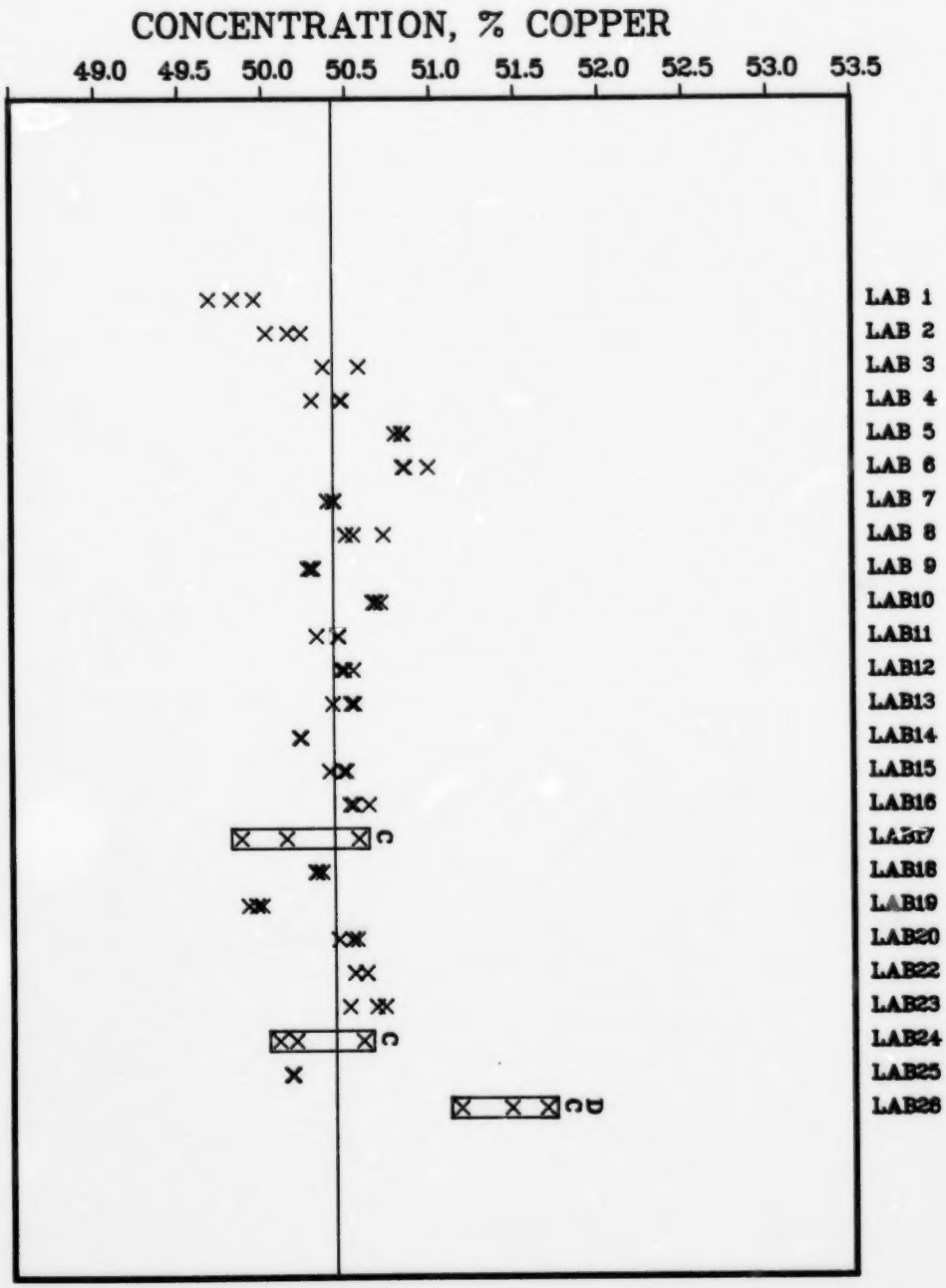
Figure 2.L.2



ISO/TC 183/WG 3A/WG 3A-8 COPPER IN COPPER CONC. LONG IODIDE METHOD

SAMPLE: 85-8

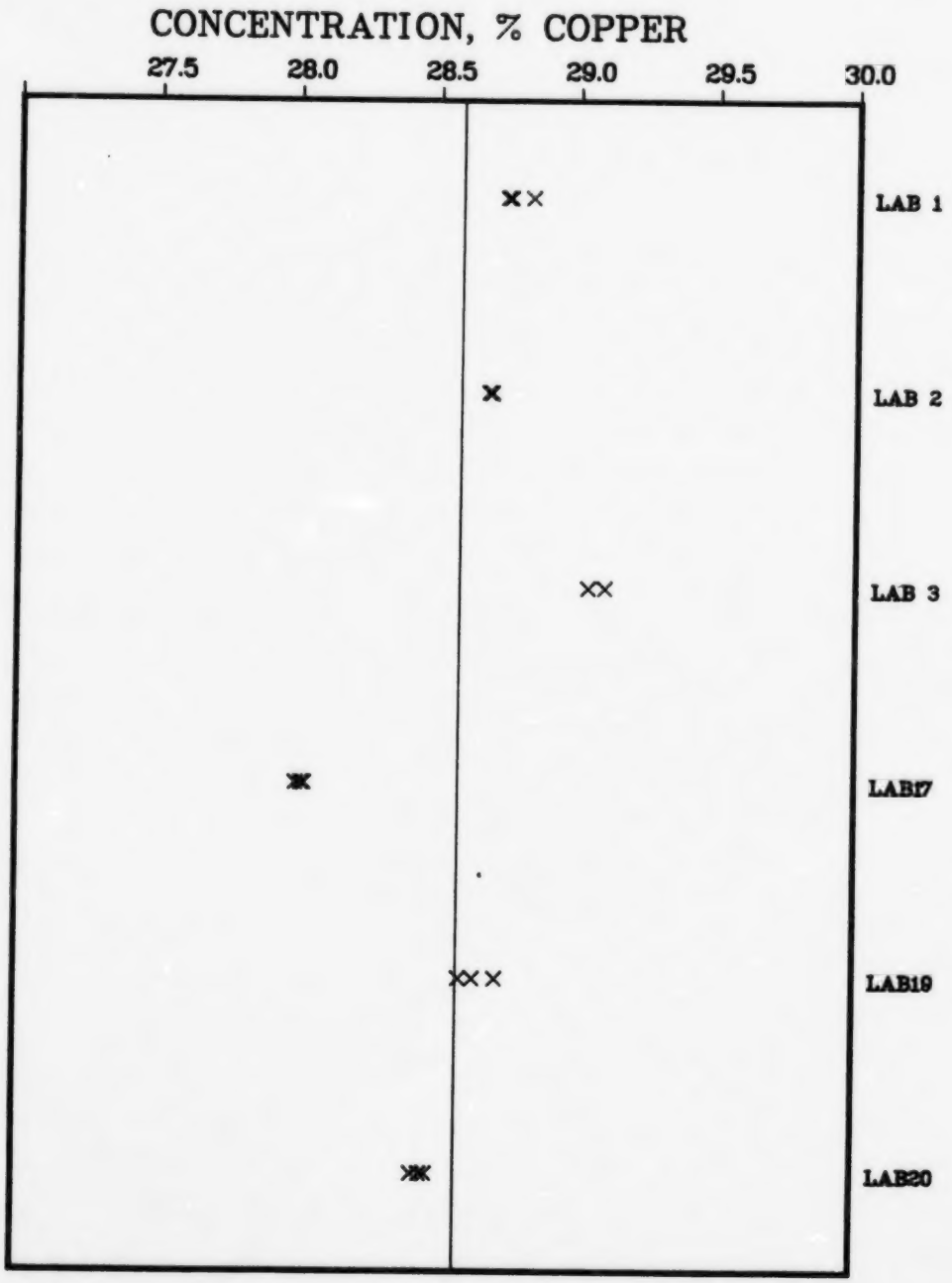
Figure 2.L.3



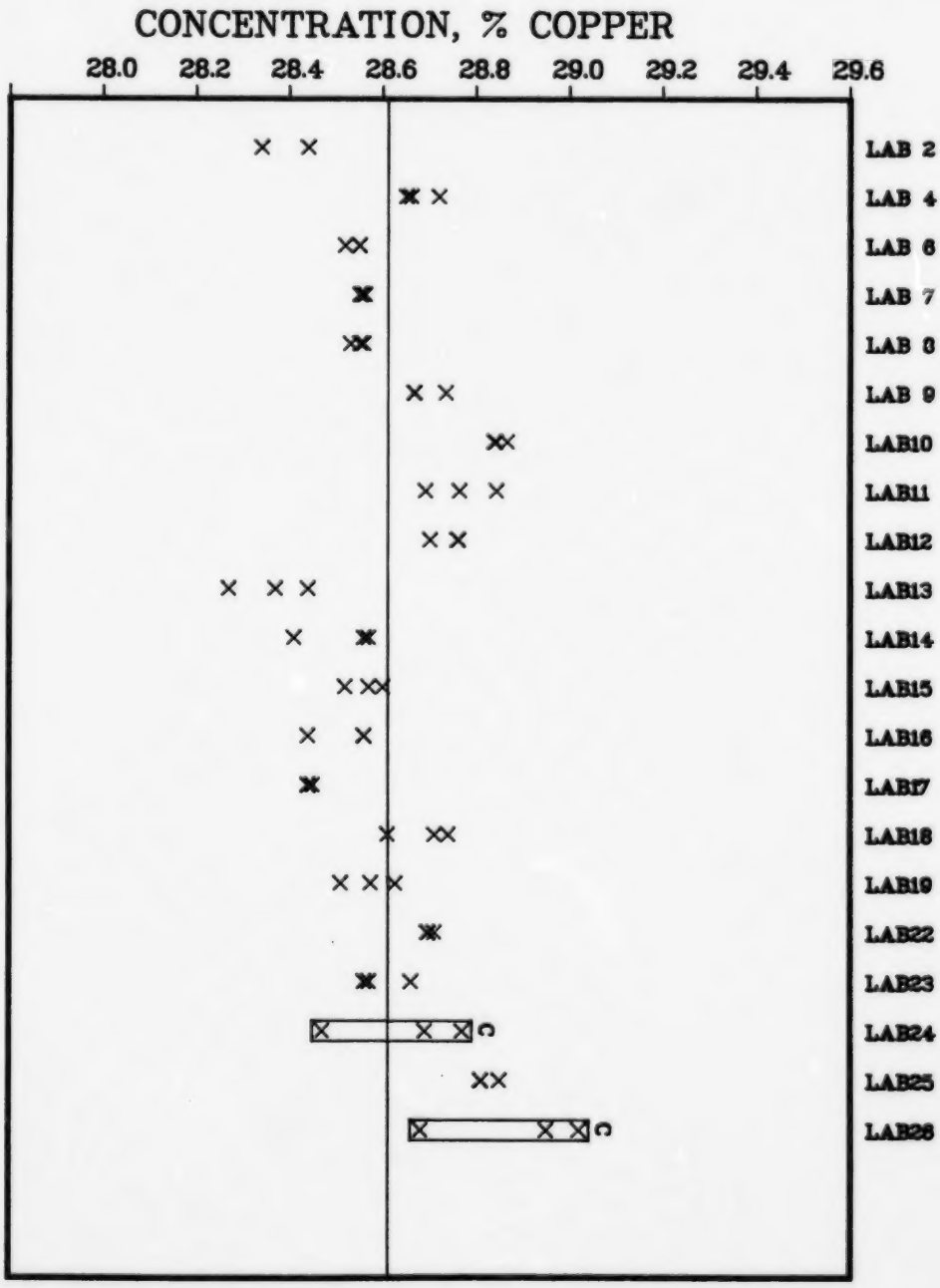
ISO/TC 183/WG 3A/WG 3A-6 COPPER IN COPPER CONC. LONG IODIDE METHOD

SAMPLE 85-9

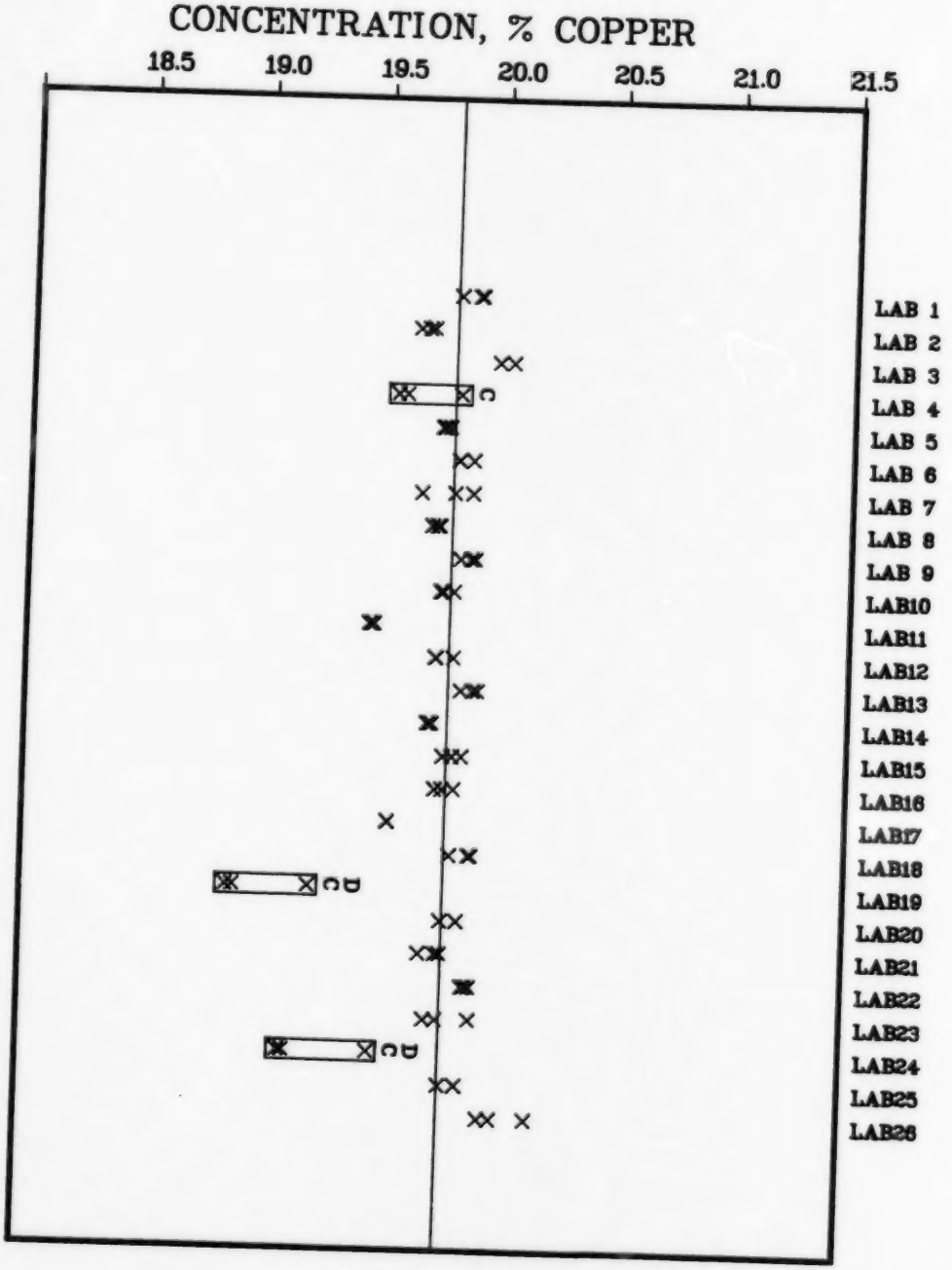
Figure 2.L.4



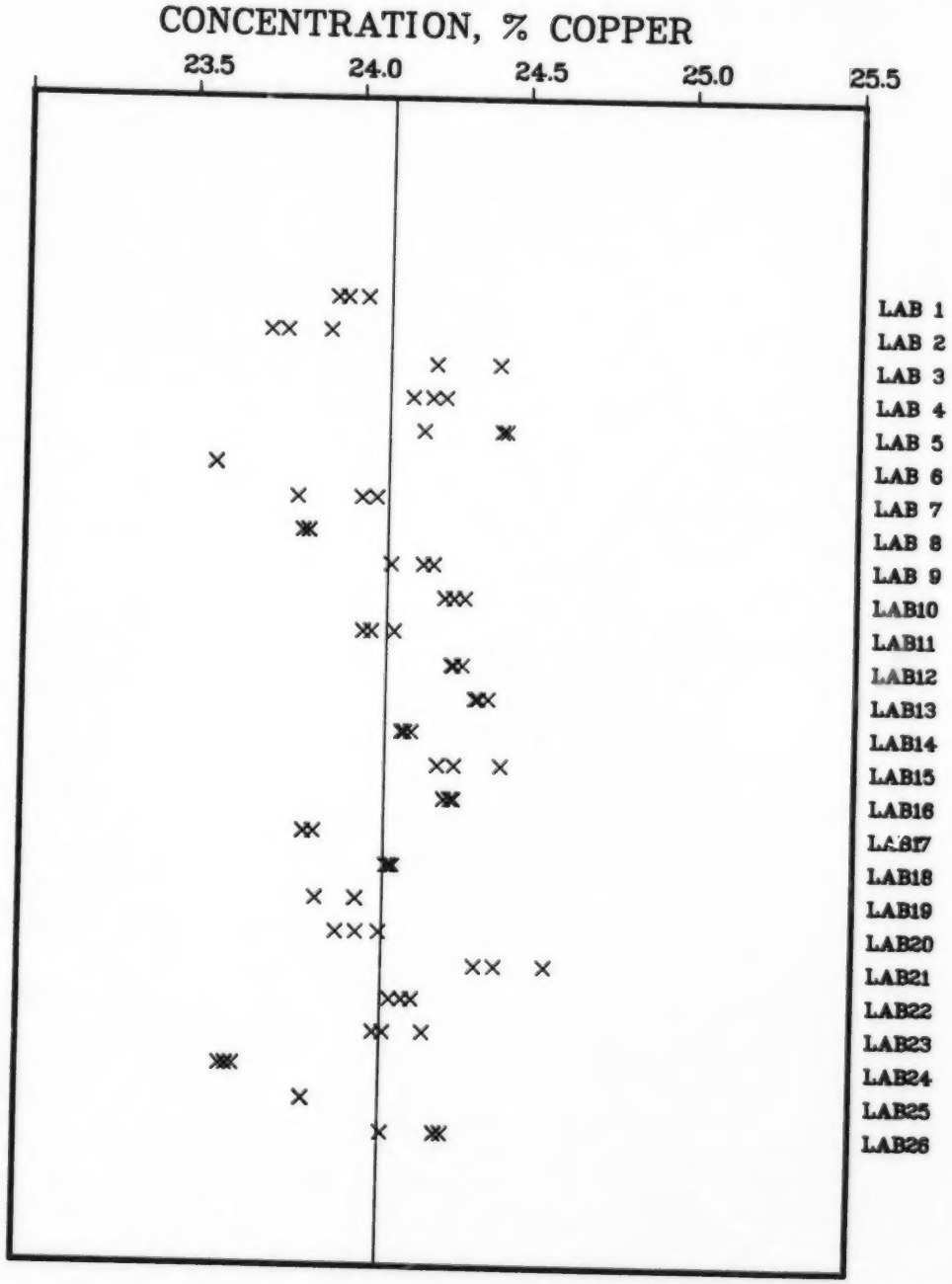
ISO/TC 183/WG 3A/WG 3A-6 COPPER IN COPPER CONC. LONG IODIDE METHOD
SAMPLE 85-10
Figure 2.L.5



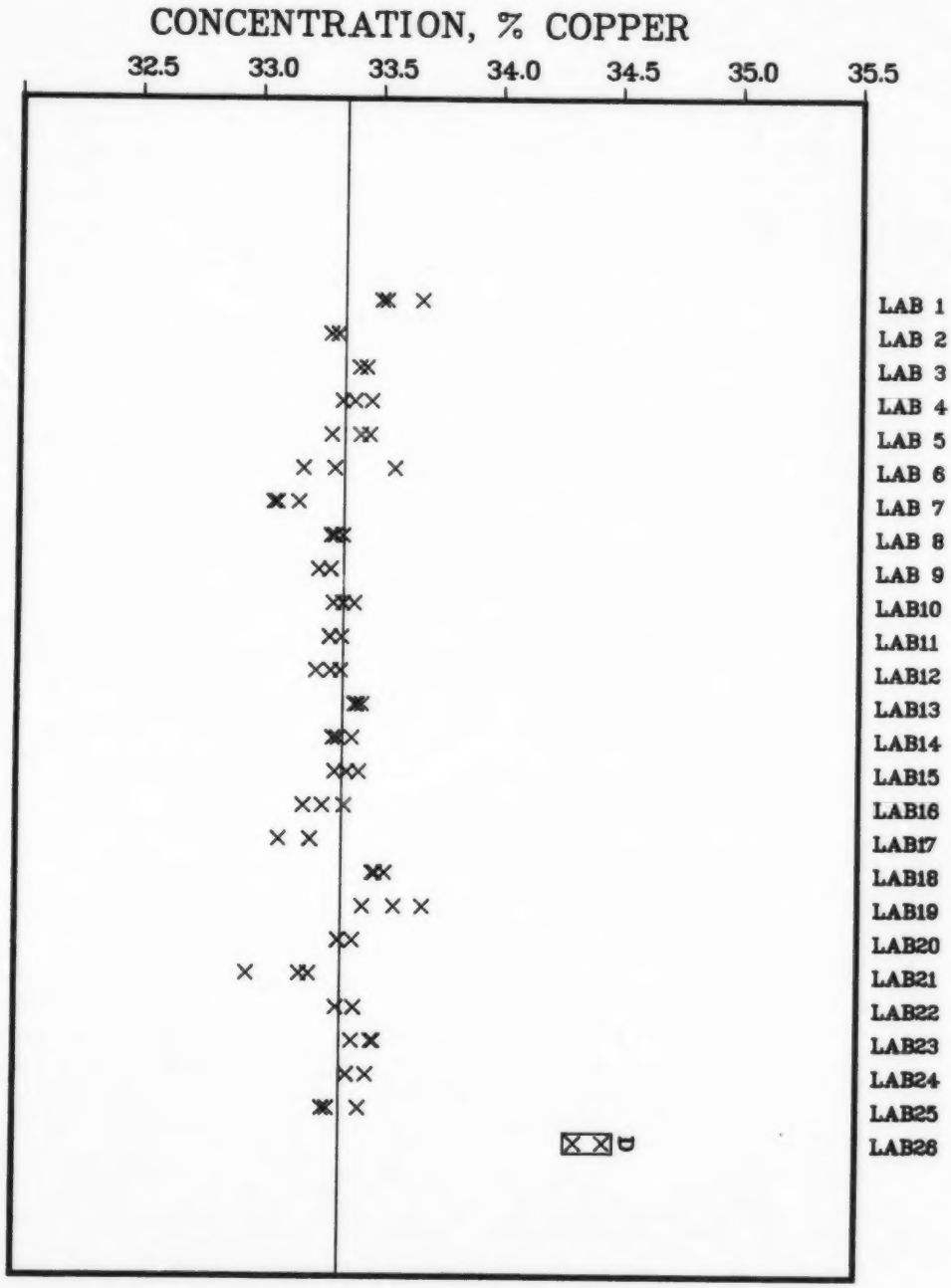
ISO/TC 183/WG 3A/WG 3A-6 COPPER IN COPPER CONC. LONG IODIDE METHOD
SAMPLE: 85-10A
Figure 2.L.6



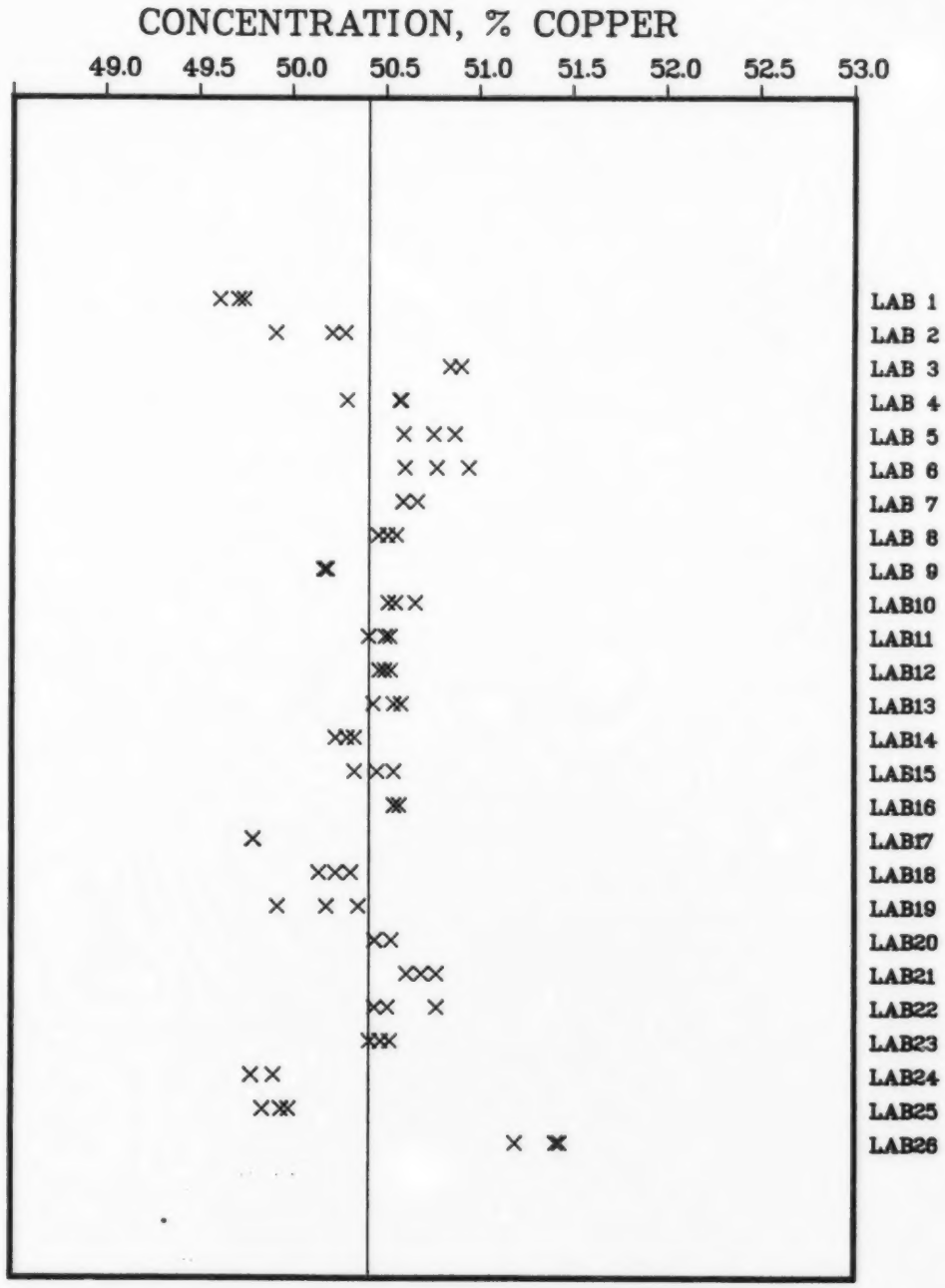
ISO/TC 183/WG 3A/WG 3A-5 COPPER IN COPPER CONC. SHORT IODIDE METHOD
SAMPLE: 85-6
Figure 2.S.1



ISO/TC 183/WG 3A/WG 3A-5 COPPER IN COPPER CONC. SHORT IODIDE METHOD
SAMPLE 85-7
Figure 2.S.2



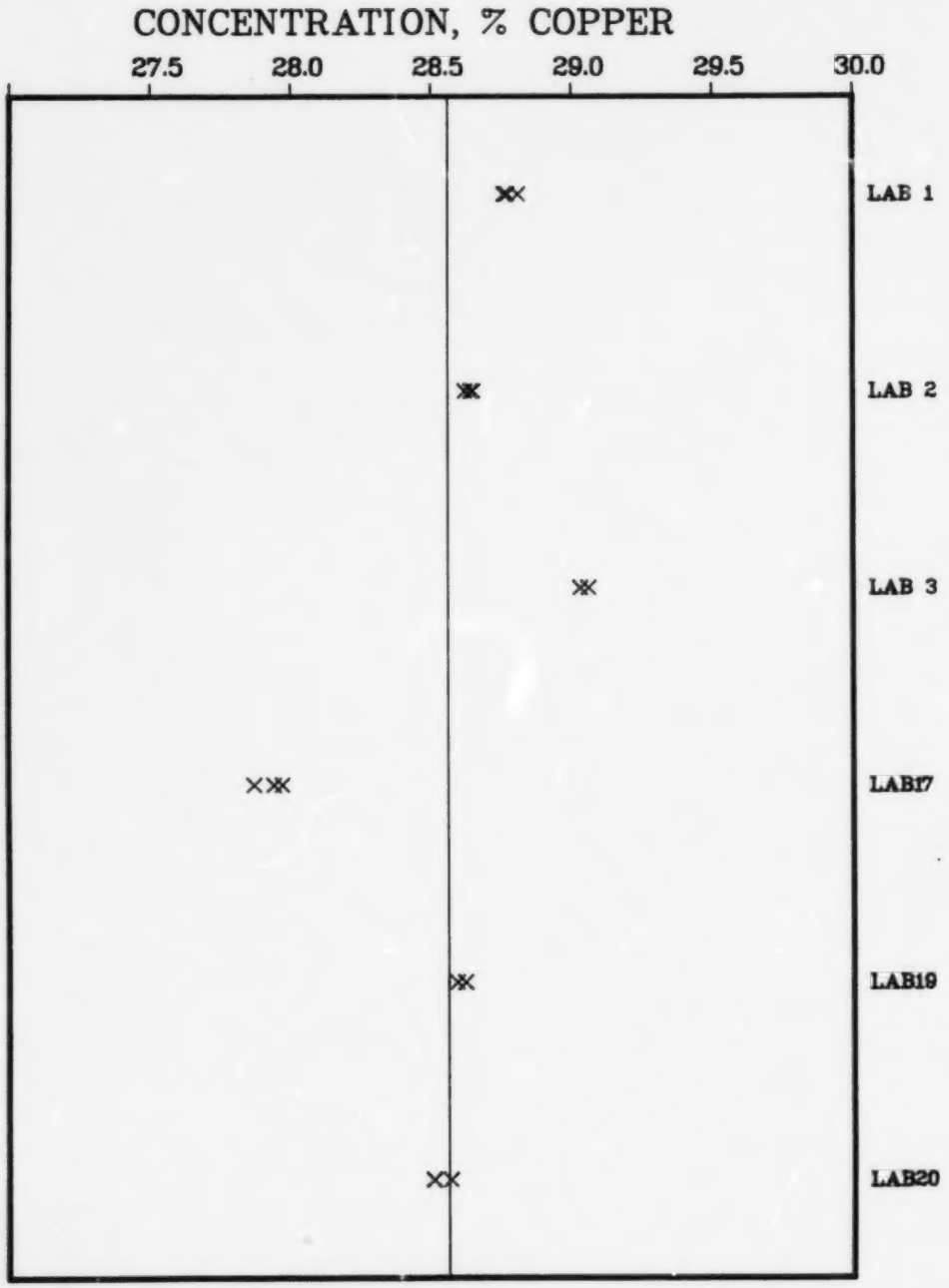
ISO/TC 183/WG 3A/WG 3A-5 COPPER IN COPPER CONC. SHORT IODIDE METHOD
SAMPLE 85-8
Figure 2.S.3



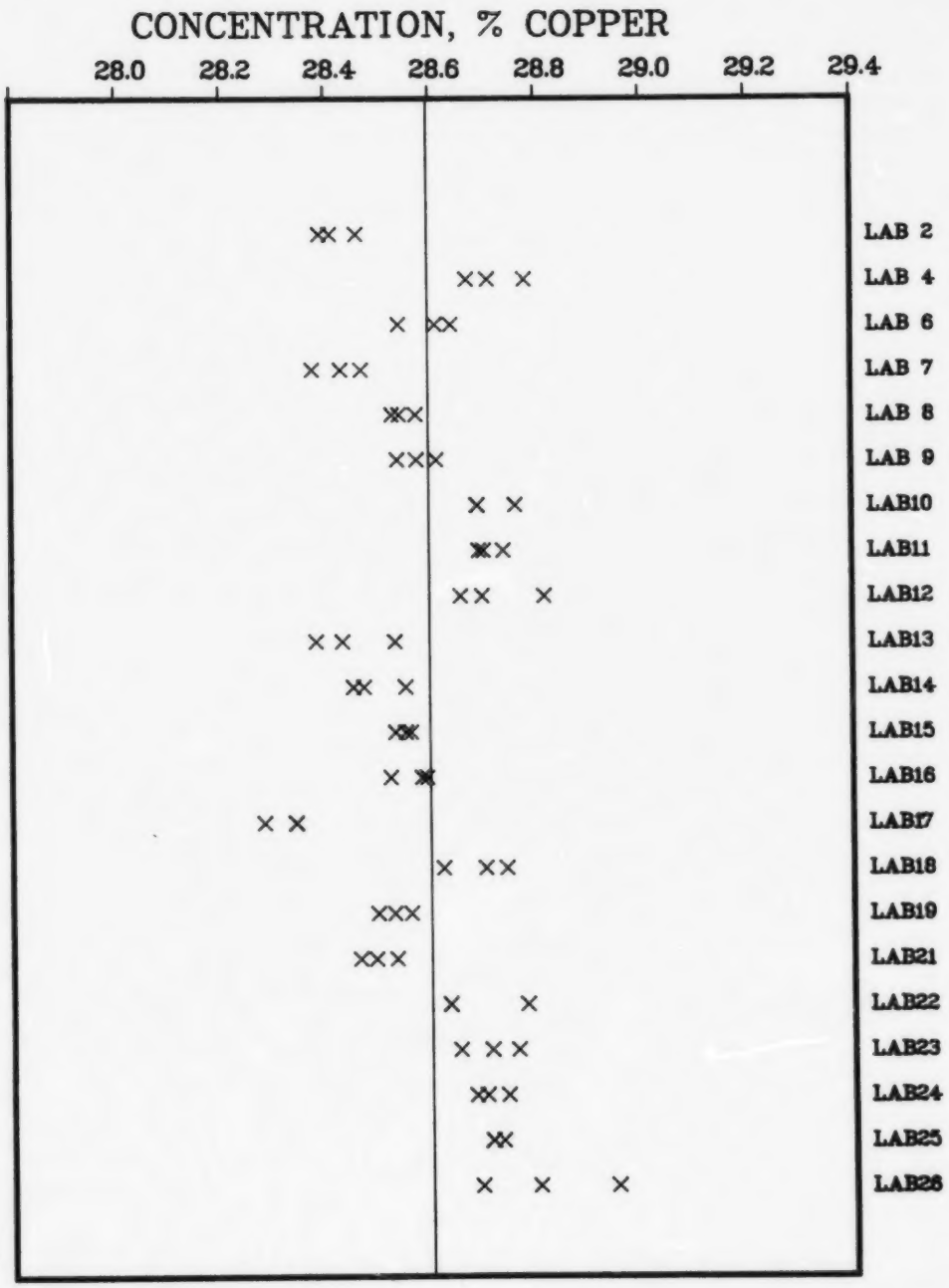
ISO/TC 183/WG 3A/WG 3A-5 COPPER IN COPPER CONC. SHORT IODIDE METHOD

SAMPLE 85-9

Figure 2.S.4



ISO/TC 183/WG 3A/WG 3A-5 COPPER IN COPPER CONC. SHORT IODIDE METHOD
SAMPLE 85-10
Figure 2.S.5



ISO/TC 183/WG 3A/WG 3A-5 COPPER IN COPPER CONC. SHORT IODIDE METHOD

SAMPLE 85-10A

Figure 2.S.6

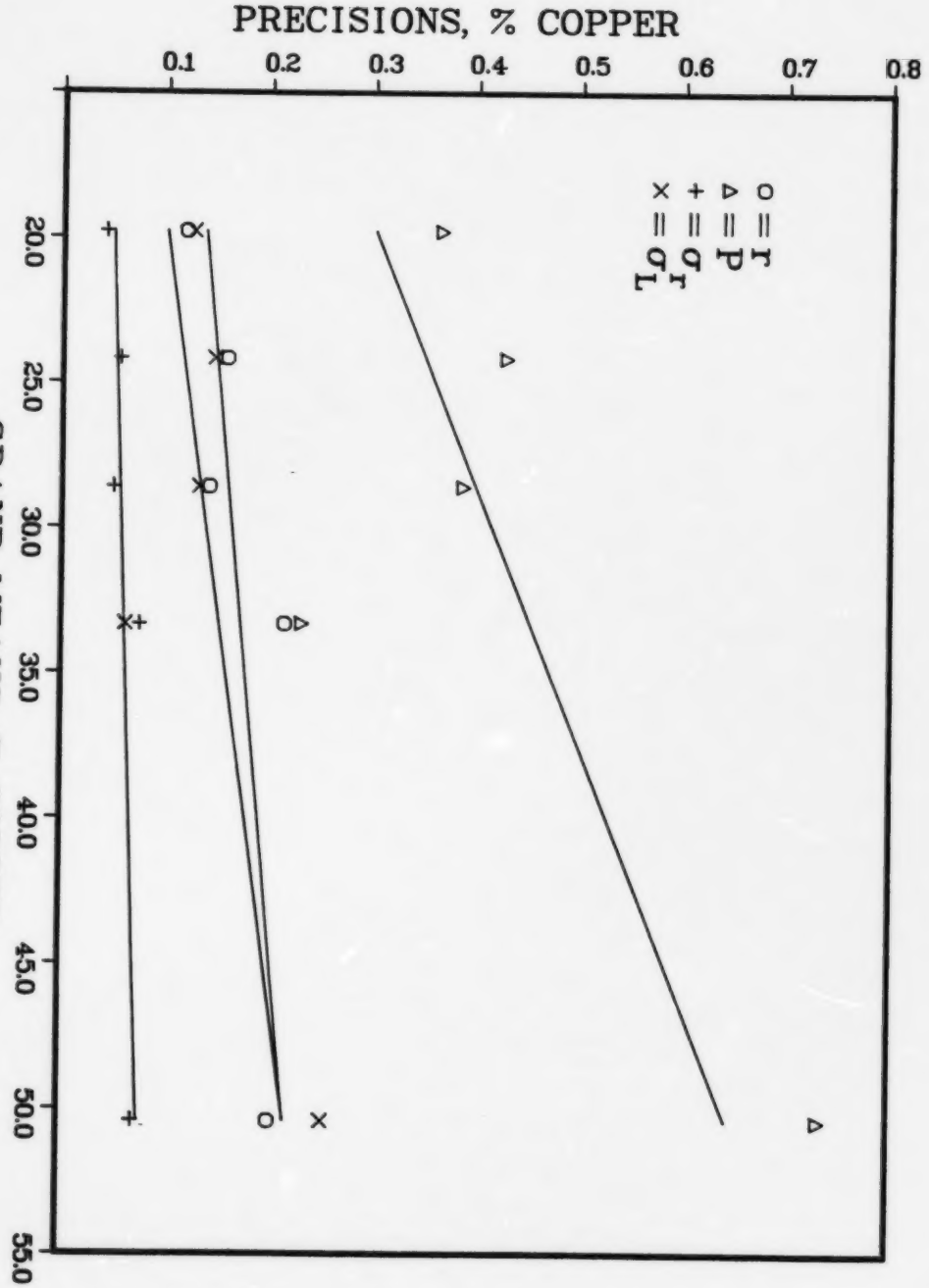


Figure 3.L

ISO/TC 183/WG 3A/WG 3A-6 COPPER IN COPPER CONC. LONG IODIDE METHOD

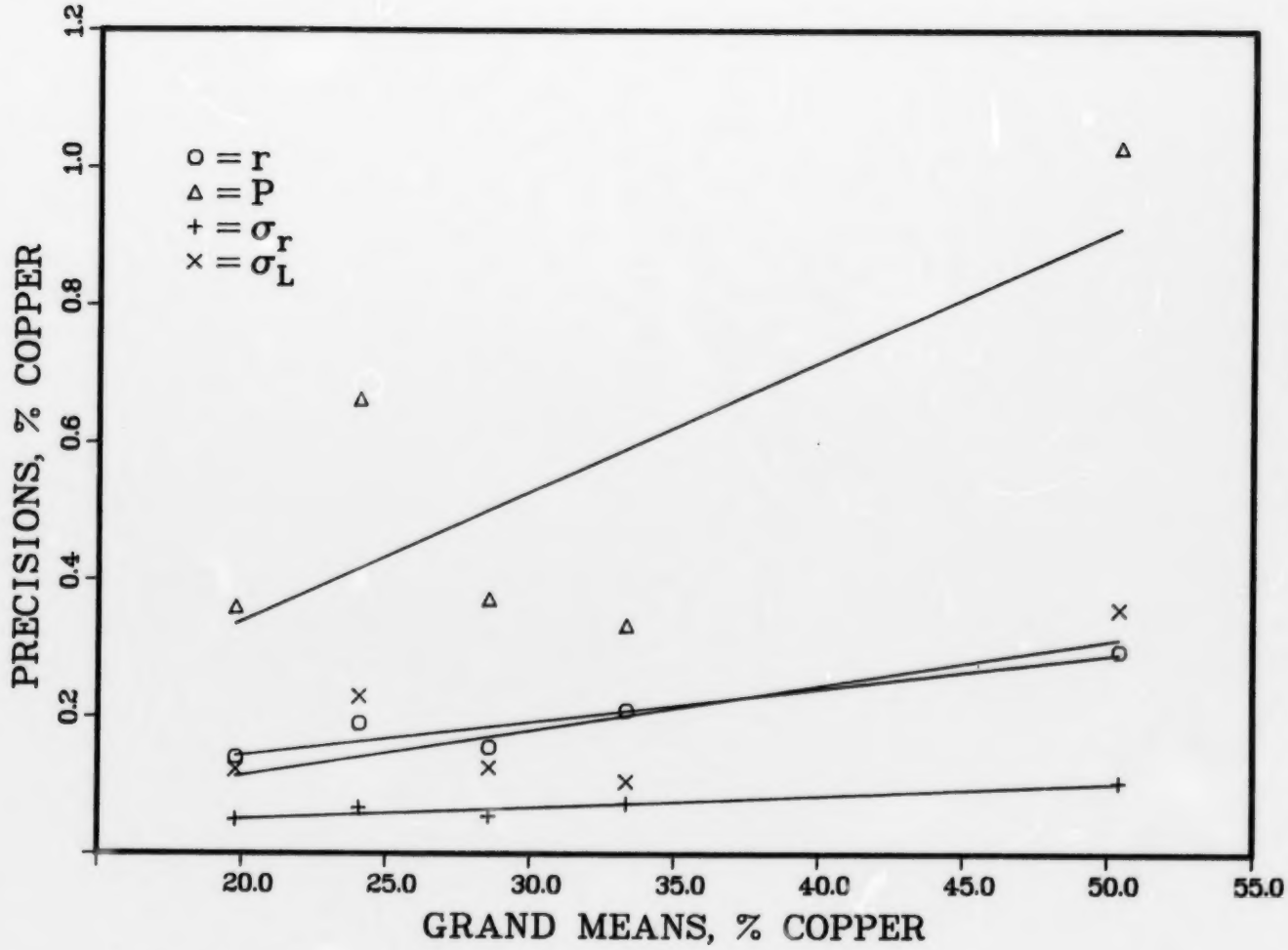


Figure 3.S
ISO/TC 183/WG 3A/WG 3A-5 COPPER IN COPPER CONC. SHORT IODIDE METHOD

APPENDIX A.L

Copper in Copper Concentrates Long Iodide Method

Detailed Computation of the Analytical DATA

A.L.1

ISO/TC 183/WG 3A/WG 3A-6 COPPER IN COPPER CONC. LONG IODIDE METHOD
SAMPLE: 85-6

LABORATORY NO.	COUNTRY	BOTTLE NO.	ANALYTICAL RESULTS COPPER			LAB MEAN	LAB VARIANCE
1	LAB 1	1	19.7500	19.8100	19.8000	19.78667	.1033E-02
2	LAB 2	1	19.7800	19.8000	19.7300	19.77000	.1300E-02
3	LAB 3	1	20.1100	20.0900		20.10000	.2000E-03
4	LAB 4	1	19.6400	19.9200	19.7100	19.75667	.2123E-01
5	LAB 5	1	19.8030	19.7580	19.7700	19.77700	.5430E-03
6	LAB 6	1	19.7300	19.7300	19.7400	19.73333	.3333E-04
7	LAB 7	1	19.7850	19.8320	19.7940	19.80367	.6223E-03
8	LAB 8	1	19.7170	19.7000	19.7120	19.70967	.7633E-04
9	LAB 9	1	19.7540	19.7350	19.7050	19.73133	.6103E-03
10	LAB10	1	19.9000	19.8850	19.9770	19.92067	.2436E-02
11	LAB11	1	19.7020	19.6250	19.6170	19.64800	.2203E-02
12	LAB12	1	19.7710	19.7930	19.8030	19.78900	.2680E-03
13	LAB13	1	19.8900	19.9700	19.7800	19.88000	.9100E-02
14	LAB14	1	19.7200	19.7700	19.7700	19.75333	.8333E-03
15	LAB15	1	19.7600	19.8200	19.8300	19.80333	.1433E-02
16	LAB16	1	19.7800	19.8700	19.8400	19.83000	.2100E-02
17	LAB17	1	19.5900	19.6400	19.6600	19.63000	.1300E-02
18	LAB18	1	19.8500	19.8700	19.8800	19.86667	.2333E-03
19	LAB19	1	19.6000	19.6800	19.5000	19.59333	.8133E-02
20	LAB20	1	19.8780	19.8480	19.8480	19.85800	.3000E-03
21	LAB22	1	19.6790	19.6980	19.7380	19.70500	.9070E-03
22	LAB23	1	19.6900	19.7200	19.7000	19.70333	.2333E-03
23	LAB24	1	19.7500	19.8000	19.7700	19.77333	.6333E-03
24	LAB25	1	19.9700	19.9300	19.9900	19.96333	.9333E-03
25	LAB26	1	20.0600	20.1900	20.1900	20.14667	.5633E-02

A.L.2

ISO/TC 183/WG 3A/WG 3A-6 COPPER IN COPPER CONC. LONG IODIDE METHOD
SAMPLE: 85-6

BARTLETT'S TEST FOR HOMOGENEITY OF LABORATORY VARIANCE

CALCULATED STATISTIC	42.372
CHI-SQUARE(.95,24)	36.421

VARIANCE IS INHOMOGENEOUS

COCHRAN'S TEST FOR LABORATORY VARIANCE

LAB- 4 C-CALC = .341 C-CRIT(3,25) = .228

DIXON'S TEST FOR LABORATORY MEANS

NONE REJECTED

LIST OF LABORATORIES WHOSE RESULTS WERE NOT USED FOR ONE-WAY ANOVA

LAB- 4 COCHRAN'S TEST FOR LABORATORY VARIANCE

LIST OF INDIVIDUAL OUTLIERS DETECTED BY DIXON'S TEST WITHIN-LABORATORIES

NONE REJECTED

A.L.3

ISO/TC 183/WG 3A/WG 3A-6 COPPER IN COPPER CONC. LONG IODIDE METHOD
SAMPLE: 85-6

ONE-WAY ANALYSIS OF VARIANCE TABLE

SOURCE OF VARIATION	D.F.	SUM OF SQUARES	MEAN SQUARE
BETWEEN LABS	23	.11146346E+01	.48462374E-01
WITHIN LABS	47	.81999334E-01	.17446667E-02
TOTAL	70	.11966339E+01	

REPEATABILITY VARIANCE	.17446667E-02
REPEATABILITY STD. DEV.	.04176921
BETWEEN-LABORATORIES VARIANCE	.15795035E-01
BETWEEN-LABORATORIES STD. DEV.	.12567830
REPEATABILITY	.11820686
PERMISSIBLE TOLERANCE BETWEEN LABS	.36535911
GRAND MEAN	19.79897183
VARIANCE OF THE GRAND MEAN	.68570197E-03

A.L.4

ISO/TC 183/WG 3A/WG 3A-6 COPPER IN COPPER CONC. LONG IODIDE METHOD
SAMPLE: 85-7

LABORATORY NO.	COUNTRY	BOTTLE NO.	ANALYTICAL RESULTS COPPER			LAB MEAN	LAB VARIANCE
1	LAB 1	1	23.9500	24.1600	24.0000	24.03667	.1203E-01
2	LAB 2	1	24.0200	23.9700	24.0300	24.00667	.1033E-02
3	LAB 3	1	24.3100	24.4000		24.35500	.4050E-02
4	LAB 4	1	24.2200	24.2000	24.2400	24.22000	.4000E-03
5	LAB 5	1	24.3270	23.8610	24.0710	24.08633	.5447E-01
6	LAB 6	1	24.2100	24.1800	24.1400	24.17667	.1233E-02
7	LAB 7	1	24.2570	24.3460	24.2660	24.28967	.2400E-02
8	LAB 8	1	23.9400	24.0460	23.9690	23.98500	.3001E-02
9	LAB 9	1	24.2650	24.1650	24.2000	24.21000	.2575E-02
10	LAB10	1	24.4660	24.4570	24.3950	24.43933	.1494E-02
11	LAB11	1	24.0840	24.1650	24.0650	24.10467	.2820E-02
12	LAB12	1	24.2800	24.2300	24.2950	24.26833	.1158E-02
13	LAB13	1	24.3700	24.4500	24.2900	24.37000	.6400E-02
14	LAB14	1	24.2500	24.1400	24.2000	24.19667	.3033E-02
15	LAB15	1	24.2000	24.3100	24.2500	24.25333	.3033E-02
16	LAB16	1	24.2200	24.2800	24.2400	24.24667	.9333E-03
17	LAB17	1	23.9500	24.0400	24.0400	24.01000	.2700E-02
18	LAB18	1	24.3400	24.2900	24.2400	24.29000	.2500E-02
19	LAB19	1	24.1800	24.0400	24.1900	24.13667	.7033E-02
20	LAB20	1	24.1730	24.1530	24.1730	24.16633	.1333E-03
21	LAB22	1	24.2420	24.1850	24.2080	24.21167	.8223E-03
22	LAB23	1	23.9900	23.7400	23.9200	23.88333	.1663E-01
23	LAB24	1	23.9800	23.9800	23.9800	23.98000	0.
24	LAB25	1	24.1300	24.1400	24.1200	24.13000	.1000E-03
25	LAB26	1	24.4800	24.4500	24.4800	24.47000	.3000E-03

A.L.5

ISO/TC 183/WG 3A/WG 3A-6 COPPER IN COPPER CONC. LONG IODIDE METHOD
SAMPLE: 85-7

BARTLETT'S TEST FOR HOMOGENEITY OF LABORATORY VARIANCE

CALCULATED STATISTIC	40.485
CHI-SQUARE(.95,23)	35.178

VARIANCE IS INHOMOGENEOUS

COCHRAN'S TEST FOR LABORATORY VARIANCE

LAB- 5 C-CALC = .418 C-CRIT(3,24) = .236

DIXON'S TEST FOR LABORATORY MEANS

NONE REJECTED

LIST OF LABORATORIES WHOSE RESULTS WERE NOT USED FOR ONE-WAY ANOVA

LAB- 5 COCHRAN'S TEST FOR LABORATORY VARIANCE

LIST OF INDIVIDUAL OUTLIERS DETECTED BY DIXON'S TEST WITHIN-LABORATORIES

NONE REJECTED

A.L.6

ISO/TC 183/WG 3A/WG 3A-6 COPPER IN COPPER CONC. LONG IODIDE METHOD
SAMPLE: 85-7

ONE-WAY ANALYSIS OF VARIANCE TABLE

SOURCE OF VARIATION	D.F.	SUM OF SQUARES	MEAN SQUARE
BETWEEN LABS	23	.15271043E+01	.66395840E-01
WITHIN LABS	47	.14759333E+00	.31402837E-02
TOTAL	70	.16746977E+01	

REPEATABILITY VARIANCE	.31402837E-02
REPEATABILITY STD. DEV.	.05603823
BETWEEN-LABORATORIES VARIANCE	.21386403E-01
BETWEEN-LABORATORIES STD. DEV.	.14624091
REPEATABILITY	.15858820
PERMISSIBLE TOLERANCE BETWEEN LABS	.42878511
GRAND MEAN	24.18246479
VARIANCE OF THE GRAND MEAN	.93939517E-03

A.L.7

ISO/TC 183/WG 3A/WG 3A-6 COPPER IN COPPER CONC. LONG IODIDE METHOD
SAMPLE: 85-8

LABORATORY NO.	COUNTRY	BOTTLE NO.	ANALYTICAL RESULTS COPPER			LAB MEAN	LAB VARIANCE
1	LAB 1	1	33.3500	33.4700	33.4400	33.42000	.3900E-02
2	LAB 2	1	33.2200	33.2200	33.3100	33.25000	.2700E-02
3	LAB 3	1	33.6900	33.6500		33.67000	.8000E-03
4	LAB 4	1	33.3200	33.4900	33.5100	33.44000	.1090E-01
5	LAB 5	1	33.4350	33.1330	33.1240	33.23067	.3133E-01
6	LAB 6	1	33.1400	33.3100	33.3100	33.25333	.9633E-02
7	LAB 7	1	33.3860	33.3670	33.4680	33.40700	.2881E-02
8	LAB 8	1	33.3290	33.2760	33.3340	33.31300	.1033E-02
9	LAB 9	1	33.3430	33.4040	33.3320	33.35967	.1504E-02
10	LAB10	1	33.4780	33.4110	33.5030	33.46400	.2263E-02
11	LAB11	1	33.2760	33.2450	33.2220	33.24767	.7343E-03
12	LAB12	1	33.3050	33.3800	33.3520	33.34567	.1436E-02
13	LAB13	1	33.3900	33.3200	33.5800	33.43000	.1810E-01
14	LAB14	1	33.2400	33.3900	33.3800	33.33667	.7033E-02
15	LAB15	1	33.3600	33.2800	33.3400	33.32667	.1733E-02
16	LAB16	1	33.3100	33.1700	33.3300	33.27000	.7600E-02
17	LAB17	1	33.3400	33.2300	33.2300	33.26667	.4033E-02
18	LAB18	1	33.3800	33.5000	33.3600	33.41333	.5733E-02
19	LAB19	1	33.1900	33.1600	33.2300	33.19333	.1233E-02
20	LAB20	1	33.4000	33.2600	33.2900	33.31667	.5433E-02
21	LAB22	1	33.3490	33.3330	33.2820	33.32133	.1224E-02
22	LAB23	1	33.3400	33.4100	33.4000	33.38333	.1433E-02
23	LAB24	1	33.1400	33.3200	33.3200	33.26000	.1080E-01
24	LAB25	1	33.3200	33.2700	33.2900	33.29333	.6333E-03
25	LAB26	1	34.7400	34.8300	34.6600	34.74333	.7233E-02

A.L.8

ISO/TC 183/WG 3A/WG 3A-6 COPPER IN COPPER CONC. LONG IODIDE METHOD
SAMPLE: 85-8

BARTLETT'S TEST FOR HOMOGENEITY OF LABORATORY VARIANCE

CALCULATED STATISTIC	22.411
CHI-SQUARE(.95,24)	36.421

VARIANCE IS HOMOGENEOUS

DIXON'S TEST FOR LABORATORY MEANS

LAB-25	R =	.855	D-CRIT(25) =	.443
LAB- 3	R =	.545	D-CRIT(24) =	.451

LIST OF LABORATORIES WHOSE RESULTS WERE NOT USED FOR ONE-WAY ANOVA

LAB- 3	DIXON'S TEST FOR LABORATORY MEANS
LAB-25	DIXON'S TEST FOR LABORATORY MEANS

LIST OF INDIVIDUAL OUTLIERS DETECTED BY DIXON'S TEST WITHIN-LABORATORIES

NONE REJECTED

A.L.9

ISO/TC 183/WG 3A/WG 3A-6 COPPER IN COPPER CONC. LONG IODIDE METHOD
SAMPLE: 85-8

ONE-WAY ANALYSIS OF VARIANCE TABLE

SOURCE OF VARIATION	D.F.	SUM OF SQUARES	MEAN SQUARE
BETWEEN LABS	22	.38086531E+00	.17312059E-01
WITHIN LABS	46	.26662133E+00	.57961159E-02
TOTAL	68	.64748664E+00	

REPEATABILITY VARIANCE	.57961159E-02
REPEATABILITY STD. DEV.	.07613223
BETWEEN-LABORATORIES VARIANCE	.38386478E-02
BETWEEN-LABORATORIES STD. DEV.	.06195682
REPEATABILITY	.21545420
PERMISSIBLE TOLERANCE BETWEEN LABS	.23227915
GRAND MEAN	33.32792754
VARIANCE OF THE GRAND MEAN	.25089941E-03

A.L.10

ISO/TC 183/WG 3A/WG 3A-6 COPPER IN COPPER CONC. LONG IODIDE METHOD
SAMPLE: 85-9

LABORATORY NO.	COUNTRY	BOTTLE NO.	ANALYTICAL RESULTS COPPER			LAB MEAN	LAB VARIANCE
1	LAB 1	1	49.6800	49.8200	49.9500	49.81667	.1823E-01
2	LAB 2	1	50.0200	50.2300	50.1500	50.13333	.1123E-01
3	LAB 3	1	50.3600	50.5700		50.46500	.2205E-01
4	LAB 4	1	50.4600	50.2900	50.4700	50.40667	.1023E-01
5	LAB 5	1	50.8340	50.8220	50.7820	50.81267	.7413E-03
6	LAB 6	1	50.8300	50.9800	50.8400	50.88333	.7033E-02
7	LAB 7	1	50.3820	50.4260	50.4150	50.40767	.5243E-03
8	LAB 8	1	50.4910	50.7140	50.5350	50.58000	.1395E-01
9	LAB 9	1	50.2970	50.2650	50.2840	50.28200	.2590E-03
10	LAB10	1	50.6510	50.6660	50.6970	50.67133	.5503E-03
11	LAB11	1	50.3150	50.4410	50.4460	50.40067	.5510E-02
12	LAB12	1	50.4810	50.4600	50.5330	50.49133	.1412E-02
13	LAB13	1	50.5200	50.5400	50.4100	50.49000	.4900E-02
14	LAB14	1	50.2100	50.2200	50.2200	50.21667	.3333E-04
15	LAB15	1	50.3900	50.4900	50.4700	50.45000	.2800E-02
16	LAB16	1	50.6200	50.5300	50.5100	50.55333	.3433E-02
17	LAB17	1	50.5600	49.8600	50.1300	50.18333	.1246E+00
18	LAB18	1	50.3100	50.3000	50.3400	50.31667	.4333E-03
19	LAB19	1	49.9800	49.9000	49.9500	49.94333	.1633E-02
20	LAB20	1	50.4380	50.5470	50.5170	50.50067	.3170E-02
21	LAB22	1	50.6010	50.5310	50.6010	50.57767	.1633E-02
22	LAB23	1	50.6600	50.5000	50.7100	50.62333	.1203E-01
23	LAB24	1	50.5800	50.1800	50.0800	50.28000	.7000E-01
24	LAB25	1	50.1600	50.1500	50.1600	50.15667	.3333E-04
25	LAB26	1	51.1600	51.4600	51.6700	51.43000	.6570E-01

A.L.11

ISO/TC 183/WG 3A/WG 3A-6 COPPER IN COPPER CONC. LONG IODIDE METHOD
SAMPLE: 85-9

BARTLETT'S TEST FOR HOMOGENEITY OF LABORATORY VARIANCE

CALCULATED STATISTIC	67.025
CHI-SQUARE(.95,24)	36.421

VARIANCE IS INHOMOGENEOUS

COCHRAN'S TEST FOR LABORATORY VARIANCE

LAB-17	C-CALC =	.326	C-CRIT(3,25) =	.228
LAB-23	C-CALC =	.272	C-CRIT(3,24) =	.236
LAB-25	C-CALC =	.350	C-CRIT(3,23) =	.243

DIXON'S TEST FOR LABORATORY MEANS

LAB-25	R =	.476	D-CRIT(25) =	.443

LIST OF LABORATORIES WHOSE RESULTS WERE NOT USED FOR ONE-WAY ANOVA

LAB-17	COCHRAN'S TEST FOR LABORATORY VARIANCE
LAB-23	COCHRAN'S TEST FOR LABORATORY VARIANCE
LAB-25	DIXON'S TEST FOR MEANS AND COCHRAN'S TEST FOR VARIANCE

LIST OF INDIVIDUAL OUTLIERS DETECTED BY DIXON'S TEST WITHIN-LABORATORIES

NONE REJECTED

A.L.12

ISO/TC 183/WG 3A/WG 3A-6 COPPER IN COPPER CONC. LONG IODIDE METHOD
SAMPLE: 85-9

ONE-WAY ANALYSIS OF VARIANCE TABLE

SOURCE OF VARIATION	D.F.	SUM OF SQUARES	MEAN SQUARE
BETWEEN LABS	21	.41238229E+01	.19637252E+00
WITHIN LABS	43	.22162133E+00	.51539845E-02
TOTAL	64	.43454443E+01	

REPEATABILITY VARIANCE	.51539845E-02
REPEATABILITY STD. DEV.	.07179126
BETWEEN-LABORATORIES VARIANCE	.64735442E-01
BETWEEN-LABORATORIES STD. DEV.	.25443161
REPEATABILITY	.20316926
PERMISSIBLE TOLERANCE BETWEEN LABS	.73423331
GRAND MEAN	50.41649231
VARIANCE OF THE GRAND MEAN	.30364377E-02

A.L.13

ISO/TC 183/WG 3A/WG 3A-6 COPPER IN COPPER CONC. LONG IODIDE METHOD
SAMPLE: 85-10A

LABORATORY NO.	COUNTRY	BOTTLE NO.	ANALYTICAL RESULTS COPPER			LAB MEAN	LAB VARIANCE
1	LAB 2	1	28.4400	28.3400		28.39000	.5000E-02
2	LAB 4	1	28.6600	28.6500	28.7200	28.67667	.1433E-02
3	LAB 6	1	28.5500	28.5500	28.5200	28.54000	.3000E-03
4	LAB 7	1	28.5560	28.5510	28.5620	28.55633	.3033E-04
5	LAB 8	1	28.5310	28.5520	28.5590	28.54733	.2123E-03
6	LAB 9	1	28.7350	28.6660	28.6680	28.68967	.1542E-02
7	LAB10	1	28.8420	28.8660	28.8380	28.84867	.2293E-03
8	LAB11	1	28.8430	28.7640	28.6910	28.76600	.5779E-02
9	LAB12	1	28.7620	28.7010	28.7600	28.74100	.1201E-02
10	LAB13	1	28.4400	28.3700	28.2700	28.36000	.7300E-02
11	LAB14	1	28.4100	28.5700	28.5600	28.51333	.8033E-02
12	LAB15	1	28.6000	28.5700	28.5200	28.56333	.1633E-02
13	LAB16	1	28.5600	28.5600	28.4400	28.52000	.4800E-02
14	LAB17	1	28.4400	28.4400	28.4500	28.44333	.3333E-04
15	LAB18	1	28.7100	28.7400	28.6100	28.68667	.4633E-02
16	LAB19	1	28.5740	28.6260	28.5100	28.57000	.3376E-02
17	LAB22	1	28.6950	28.7100	28.6970	28.70067	.6633E-04
18	LAB23	1	28.5700	28.6600	28.5600	28.59667	.3033E-02
19	LAB24	1	28.6900	28.7700	28.4700	28.64333	.2413E-01
20	LAB25	1	28.8500	28.8100	28.8100	28.82333	.5333E-03
21	LAB26	1	28.6800	29.0200	28.9500	28.88333	.3223E-01

A.L.14

ISO/TC 183/WG 3A/WG 3A-6 COPPER IN COPPER CONC. LONG IODIDE METHOD
SAMPLE: 85-10A

BARTLETT'S TEST FOR HOMOGENEITY OF LABORATORY VARIANCE

CALCULATED STATISTIC	46.297
CHI-SQUARE(.95,20)	31.416

VARIANCE IS INHOMOGENEOUS

COCHRAN'S TEST FOR LABORATORY VARIANCE

LAB-21	C-CALC =	.305	C-CRIT(3,21) =	.261
LAB-19	C-CALC =	.329	C-CRIT(3,20) =	.270

DIXON'S TEST FOR LABORATORY MEANS

NONE REJECTED

LIST OF LABORATORIES WHOSE RESULTS WERE NOT USED FOR ONE-WAY ANOVA

LAB-19	COCHRAN'S TEST FOR LABORATORY VARIANCE
LAB-21	COCHRAN'S TEST FOR LABORATORY VARIANCE

LIST OF INDIVIDUAL OUTLIERS DETECTED BY DIXON'S TEST WITHIN-LABORATORIES

NONE REJECTED

A.L.15

ISO/TC 183/WG 3A/WG 3A-6 COPPER IN COPPER CONC. LONG IODIDE METHOD
SAMPLE: 85-10A

ONE-WAY ANALYSIS OF VARIANCE TABLE

SOURCE OF VARIATION	D.F.	SUM OF SQUARES	MEAN SQUARE
BETWEEN LABS	18	.97349013E+00	.54082785E-01
WITHIN LABS	37	.93340000E-01	.25227027E-02
TOTAL	55	.10668301E+01	

REPEATABILITY VARIANCE	.25227027E-02
REPEATABILITY STD. DEV.	.05022651
BETWEEN-LABORATORIES VARIANCE	.17499179E-01
BETWEEN-LABORATORIES STD. DEV.	.13228446
REPEATABILITY	.14214103
PERMISSIBLE TOLERANCE BETWEEN LABS	.38762252
GRAND MEAN	28.61087500
VARIANCE OF THE GRAND MEAN	.97134411E-03

APPENDIX A.S

Copper in Copper Concentrates Short Iodide Method

Detailed Computation of the Analytical Data

A.S.1

ISO/TC 183/WG 3A/WG 3A-5 COPPER IN COPPER CONC. SHORT IODIDE METHOD
SAMPLE: 85-6

LABORATORY NO.	COUNTRY	BOTTLE NO.	ANALYTICAL RESULTS COPPER			LAB MEAN	LAB VARIANCE
1	LAB 1	1	19.9000	19.8100	19.8900	19.86667	.2433E-02
2	LAB 2	1	19.7000	19.6400	19.6800	19.67333	.9333E-03
3	LAB 3	1	20.0400	19.9800		20.01000	.1800E-02
4	LAB 4	1	19.5500	19.8200	19.5900	19.65333	.2123E-01
5	LAB 5	1	19.7780	19.7570	19.7470	19.76067	.2503E-03
6	LAB 6	1	19.8200	19.8200	19.8800	19.84000	.1200E-02
7	LAB 7	1	19.6630	19.8810	19.8040	19.78267	.1222E-01
8	LAB 8	1	19.7440	19.7110	19.7340	19.72967	.2863E-03
9	LAB 9	1	19.8980	19.8800	19.8350	19.87100	.1053E-02
10	LAB10	1	19.8120	19.7660	19.7550	19.77767	.9143E-03
11	LAB11	1	19.4610	19.4720	19.4530	19.46200	.9100E-04
12	LAB12	1	19.7430	19.8160	19.7390	19.76600	.1879E-02
13	LAB13	1	19.9200	19.9000	19.8500	19.89000	.1300E-02
14	LAB14	1	19.7200	19.7300	19.7100	19.72000	.1000E-03
15	LAB15	1	19.8600	19.7800	19.8200	19.82000	.1600E-02
16	LAB16	1	19.7800	19.7500	19.8300	19.78667	.1633E-02
17	LAB17	1	19.5500	19.5500	19.5500	19.55000	0.
18	LAB18	1	19.9000	19.9100	19.8200	19.87667	.2433E-02
19	LAB19	1	18.9000	19.2200	18.8700	18.99667	.3763E-01
20	LAB20	1	19.8580	19.8580	19.7890	19.83500	.1587E-02
21	LAB21	1	19.7000	19.7700	19.7900	19.75333	.2233E-02
22	LAB22	1	19.8980	19.9170	19.8860	19.90033	.2443E-03
23	LAB23	1	19.7300	19.9200	19.7800	19.81000	.9700E-02
24	LAB24	1	19.4900	19.1300	19.1100	19.24333	.4573E-01
25	LAB25	1	19.8700	19.8000	19.8700	19.84667	.1633E-02
26	LAB26	1	20.1700	19.9700	20.0200	20.05333	.1083E-01

A.S.2

ISO/TC 183/WG 3A/WG 3A-5 COPPER IN COPPER CONC. SHORT IODIDE METHOD
SAMPLE: 85-6

BARTLETT'S TEST FOR HOMOGENEITY OF LABORATORY VARIANCE

CALCULATED STATISTIC	53.049
CHI-SQUARE(.95,24)	36.421

VARIANCE IS INHOMOGENEOUS

COCHRAN'S TEST FOR LABORATORY VARIANCE

LAB-24	C-CALC =	.284	C-CRIT(3,25) =	.228
LAB-19	C-CALC =	.327	C-CRIT(3,24) =	.236
LAB- 4	C-CALC =	.274	C-CRIT(3,23) =	.243

DIXON'S TEST FOR LABORATORY MEANS

LAB-19	R =	.515	D-CRIT(26) =	.436
LAB-24	R =	.467	D-CRIT(25) =	.443

LIST OF LABORATORIES WHOSE RESULTS WERE NOT USED FOR ONE-WAY ANOVA

LAB- 4	COCHRAN'S TEST FOR LABORATORY VARIANCE
LAB-19	DIXON'S TEST FOR MEANS AND COCHRAN'S TEST FOR VARIANCE
LAB-24	DIXON'S TEST FOR MEANS AND COCHRAN'S TEST FOR VARIANCE

LIST OF INDIVIDUAL OUTLIERS DETECTED BY DIXON'S TEST WITHIN-LABORATORIES

NONE REJECTED

A.S.3

ISO/TC 183/WG 3A/WG 3A-5 COPPER IN COPPER CONC. SHORT IODIDE METHOD
SAMPLE: 85-6

ONE-WAY ANALYSIS OF VARIANCE TABLE

SOURCE OF VARIATION	D.F.	SUM OF SQUARES	MEAN SQUARE
BETWEEN LABS	22	.10267783E+01	.46671740E-01
WITHIN LABS	45	.11092200E+00	.24649333E-02
TOTAL	67	.11377003E+01	

REPEATABILITY VARIANCE	.24649333E-02
REPEATABILITY STD. DEV.	.04964810
BETWEEN-LABORATORIES VARIANCE	.14955537E-01
BETWEEN-LABORATORIES STD. DEV.	.12229283
REPEATABILITY	.14050411
PERMISSIBLE TOLERANCE BETWEEN LABS	.36006680
GRAND MEAN	19.79610294
VARIANCE OF THE GRAND MEAN	.68958345E-03

A.S.4

ISO/TC 183/WG 3A/WG 3A-5 COPPER IN COPPER CONC. SHORT IODIDE METHOD
SAMPLE: 85-7

LABORATORY NO.	COUNTRY	BOTTLE NO.	ANALYTICAL RESULTS COPPER			LAB MEAN	LAB VARIANCE
1	LAB 1	1	23.9300	23.9600	24.0200	23.97000	.2100E-02
2	LAB 2	1	23.9100	23.7300	23.7800	23.80667	.8633E-02
3	LAB 3	1	24.4200	24.2300		24.32500	.1805E-01
4	LAB 4	1	24.2200	24.1600	24.2600	24.21333	.2533E-02
5	LAB 5	1	24.4440	24.4300	24.1960	24.35667	.1941E-01
6	LAB 6	1	23.5700	23.5700	23.5700	23.57000	.3638E-11
7	LAB 7	1	24.0550	23.8180	24.0110	23.96133	.1589E-01
8	LAB 8	1	23.8520	23.8350	23.8540	23.84700	.1090E-03
9	LAB 9	1	24.1020	24.2300	24.1990	24.17700	.4459E-02
10	LAB10	1	24.3260	24.2650	24.2930	24.29467	.9323E-03
11	LAB11	1	24.1140	24.0440	24.0190	24.05900	.2425E-02
12	LAB12	1	24.2940	24.3210	24.2880	24.30100	.3090E-03
13	LAB13	1	24.4000	24.3600	24.3700	24.37667	.4333E-03
14	LAB14	1	24.1500	24.1700	24.1400	24.15333	.2333E-03
15	LAB15	1	24.2500	24.3000	24.4400	24.33000	.9700E-02
16	LAB16	1	24.2700	24.2900	24.3000	24.28667	.2333E-03
17	LAB17	1	23.8500	23.8500	23.8800	23.86000	.3000E-03
18	LAB18	1	24.1000	24.1200	24.1100	24.11000	.1000E-03
19	LAB19	1	24.0100	23.8900	24.0100	23.97000	.4800E-02
20	LAB20	1	24.0820	24.0130	23.9530	24.01600	.4167E-02
21	LAB21	1	24.5800	24.3700	24.4300	24.46000	.1170E-01
22	LAB22	1	24.1180	24.1550	24.1850	24.15267	.1126E-02
23	LAB23	1	24.0700	24.2200	24.1000	24.13000	.6300E-02
24	LAB24	1	23.6100	23.6300	23.6500	23.63000	.4000E-03
25	LAB25	1	23.8600	23.8600	23.8600	23.86000	0.
26	LAB26	1	24.1000	24.2800	24.2600	24.21333	.9733E-02

A.S.5

ISO/TC 183/WG 3A/WG 3A-5 COPPER IN COPPER CONC. SHORT IODIDE METHOD
SAMPLE: 85-7

BARTLETT'S TEST FOR HOMOGENEITY OF LABORATORY VARIANCE

CALCULATED STATISTIC	73.896
CHI-SQUARE(.95,24)	36.421

VARIANCE IS INHOMOGENEOUS

COCHRAN'S TEST FOR LABORATORY VARIANCE

NONE REJECTED

DIXON'S TEST FOR LABORATORY MEANS

NONE REJECTED

LIST OF LABORATORIES WHOSE RESULTS WERE NOT USED FOR ONE-WAY ANOVA

ALL RESULTS WERE USED EXCEPT INDIVIDUAL REPLICATES LISTED BELOW

LIST OF INDIVIDUAL OUTLIERS DETECTED BY DIXON'S TEST WITHIN-LABORATORIES

NONE REJECTED

A.S.6

ISO/TC 183/WG 3A/WG 3A-5 COPPER IN COPPER CONC. SHORT IODIDE METHOD
SAMPLE: 85-7

ONE-WAY ANALYSIS OF VARIANCE TABLE

SOURCE OF VARIATION	D.F.	SUM OF SQUARES	MEAN SQUARE
BETWEEN LABS	25	.40096065E+01	.16038426E+00
WITHIN LABS	51	.23010867E+00	.45119346E-02
TOTAL	76	.42397152E+01	

REPEATABILITY VARIANCE	.45119346E-02
REPEATABILITY STD. DEV.	.06717094
BETWEEN-LABORATORIES VARIANCE	.32641092E-01
BETWEEN-LABORATORIES STD. DEV.	.22943647
REPEATABILITY	.19009375
PERMISSIBLE TOLERANCE BETWEEN LABS	.66307244
GRAND MEAN	24.09046753
VARIANCE OF THE GRAND MEAN	.20917910E-02

A.S.7

ISO/TC 183/WG 3A/WG 3A-5 COPPER IN COPPER CONC. SHORT IODIDE METHOD
SAMPLE: 85-8

LABORATORY NO.	COUNTRY	BOTTLE NO.	ANALYTICAL RESULTS COPPER			LAB MEAN	LAB VARIANCE
1	LAB 1	1	33.5000	33.5200	33.6700	33.56333	.8633E-02
2	LAB 2	1	33.3200	33.3200	33.2900	33.31000	.3000E-03
3	LAB 3	1	33.4100	33.4400		33.42500	.4500E-03
4	LAB 4	1	33.3900	33.3400	33.4600	33.39667	.3633E-02
5	LAB 5	1	33.4150	33.4530	33.2960	33.38800	.6709E-02
6	LAB 6	1	33.5600	33.1800	33.3100	33.35000	.3730E-01
7	LAB 7	1	33.0580	33.0730	33.1620	33.09767	.3160E-02
8	LAB 8	1	33.3460	33.2970	33.3130	33.31867	.6243E-03
9	LAB 9	1	33.2960	33.2460	33.2960	33.27933	.8333E-03
10	LAB10	1	33.3490	33.3950	33.3080	33.35067	.1894E-02
11	LAB11	1	33.2950	33.3440	33.2940	33.31100	.8170E-03
12	LAB12	1	33.2390	33.2990	33.3410	33.29300	.2628E-02
13	LAB13	1	33.4000	33.4100	33.4300	33.41333	.2333E-03
14	LAB14	1	33.3100	33.3300	33.3900	33.34333	.1733E-02
15	LAB15	1	33.3700	33.3200	33.4200	33.37000	.2500E-02
16	LAB16	1	33.1900	33.2700	33.3600	33.27333	.7233E-02
17	LAB17	1	33.0900	33.2200	33.2200	33.17667	.5633E-02
18	LAB18	1	33.4800	33.4900	33.5300	33.50000	.7000E-03
19	LAB19	1	33.6900	33.5700	33.4400	33.56667	.1563E-01
20	LAB20	1	33.3400	33.3400	33.4000	33.36000	.1200E-02
21	LAB21	1	32.9600	33.2200	33.1800	33.12000	.1960E-01
22	LAB22	1	33.4070	33.3340	33.4070	33.38267	.1776E-02
23	LAB23	1	33.4900	33.4000	33.4800	33.45667	.2433E-02
24	LAB24	1	33.4600	33.3800	33.3800	33.40667	.2133E-02
25	LAB25	1	33.3000	33.4300	33.2800	33.33667	.6633E-02
26	LAB26	1	34.3300	34.4500	34.3300	34.37000	.4800E-02

A.S.8

ISO/TC 183/WG 3A/WG 3A-5 COPPER IN COPPER CONC. SHORT IODIDE METHOD
SAMPLE: 85-8

BARTLETT'S TEST FOR HOMOGENEITY OF LABORATORY VARIANCE

CALCULATED STATISTIC	32.255
CHI-SQUARE(.95,25)	37.660

VARIANCE IS HOMOGENEOUS

DIXON'S TEST FOR LABORATORY MEANS

LAB-26 R = .676 D-CRIT(26) = .436

LIST OF LABORATORIES WHOSE RESULTS WERE NOT USED FOR ONE-WAY ANOVA

LAB-26 DIXON'S TEST FOR LABORATORY MEANS

LIST OF INDIVIDUAL OUTLIERS DETECTED BY DIXON'S TEST WITHIN-LABORATORIES

NONE REJECTED

A.S.9

ISO/TC 183/WG 3A/WG 3A-5 COPPER IN COPPER CONC. SHORT IODIDE METHOD
SAMPLE: 85-8

ONE-WAY ANALYSIS OF VARIANCE TABLE

SOURCE OF VARIATION	D.F.	SUM OF SQUARES	MEAN SQUARE
BETWEEN LABS	24	.92264602E+00	.38443584E-01
WITHIN LABS	49	.26840200E+00	.54775918E-02
TOTAL	73	.11910480E+01	

REPEATABILITY VARIANCE	.54775918E-02
REPEATABILITY STD. DEV.	.07401075
BETWEEN-LABORATORIES VARIANCE	.11139194E-01
BETWEEN-LABORATORIES STD. DEV.	.10554238
REPEATABILITY	.20945044
PERMISSIBLE TOLERANCE BETWEEN LABS	.33338781
GRAND MEAN	33.35058108
VARIANCE OF THE GRAND MEAN	.52154208E-03

A.S.10

ISO/TC 183/WG 3A/WG 3A-5 COPPER IN COPPER CONC. SHORT IODIDE METHOD
SAMPLE: 85-9

LABORATORY NO.	COUNTRY	BOTTLE NO.	ANALYTICAL RESULTS COPPER			LAB MEAN	LAB VARIANCE
1	LAB 1	1	49.7100	49.7400	49.6100	49.68667	.4633E-02
2	LAB 2	1	49.9100	50.2800	50.2100	50.13333	.3863E-01
3	LAB 3	1	50.9000	50.8400		50.87000	.1800E-02
4	LAB 4	1	50.5700	50.2900	50.5800	50.48000	.2710E-01
5	LAB 5	1	50.5940	50.8660	50.7530	50.73767	.1867E-01
6	LAB 6	1	50.6000	50.9400	50.7700	50.77000	.2890E-01
7	LAB 7	1	50.5910	50.6670	50.5890	50.61567	.1977E-02
8	LAB 8	1	50.4560	50.5550	50.5060	50.50567	.2450E-02
9	LAB 9	1	50.1840	50.1840	50.1670	50.17833	.9633E-04
10	LAB10	1	50.6560	50.5090	50.5490	50.57133	.5776E-02
11	LAB11	1	50.4050	50.5200	50.4940	50.47300	.3637E-02
12	LAB12	1	50.4910	50.5250	50.4620	50.49267	.9943E-03
13	LAB13	1	50.4300	50.5400	50.5800	50.51667	.6033E-02
14	LAB14	1	50.2300	50.2900	50.3300	50.28333	.2533E-02
15	LAB15	1	50.4500	50.3300	50.5400	50.44000	.1110E-01
16	LAB16	1	50.5400	50.5700	50.5400	50.55000	.3000E-03
17	LAB17	1	49.7900	49.7900	49.7900	49.79000	0.
18	LAB18	1	50.3100	50.1400	50.2300	50.22667	.7233E-02
19	LAB19	1	50.1800	49.9200	50.3500	50.15000	.4690E-01
20	LAB20	1	50.5270	50.4380	50.4380	50.46767	.2640E-02
21	LAB21	1	50.7700	50.6100	50.6900	50.69000	.6400E-02
22	LAB22	1	50.7700	50.5070	50.4370	50.57133	.3083E-01
23	LAB23	1	50.4100	50.4700	50.5200	50.46667	.3033E-02
24	LAB24	1	49.7800	49.9000	49.7800	49.82000	.4800E-02
25	LAB25	1	49.9400	49.8400	49.9800	49.92000	.5200E-02
26	LAB26	1	51.4300	51.1900	51.4100	51.34333	.1773E-01

A.S.11

ISO/TC 183/WG 3A/WG 3A-5 COPPER IN COPPER CONC. SHORT IODIDE METHOD
SAMPLE: 85-9

BARTLETT'S TEST FOR HOMOGENEITY OF LABORATORY VARIANCE

CALCULATED STATISTIC	32.179
CHI-SQUARE(.95,24)	36.421

VARIANCE IS HOMOGENEOUS

DIXON'S TEST FOR LABORATORY MEANS

NONE REJECTED

LIST OF LABORATORIES WHOSE RESULTS WERE NOT USED FOR ONE-WAY ANOVA

ALL RESULTS WERE USED EXCEPT INDIVIDUAL REPLICATES LISTED BELOW

LIST OF INDIVIDUAL OUTLIERS DETECTED BY DIXON'S TEST WITHIN-LABORATORIES

NONE REJECTED

A.S.12

ISO/TC 183/WG 3A/WG 3A-5 COPPER IN COPPER CONC. SHORT IODIDE METHOD
SAMPLE: 85-9

ONE-WAY ANALYSIS OF VARIANCE TABLE

SOURCE OF VARIATION	D.F.	SUM OF SQUARES	MEAN SQUARE
BETWEEN LABS	25	.96848772E+01	.38739509E+00
WITHIN LABS	51	.55700800E+00	.10921726E-01
TOTAL	76	.10241885E+02	

REPEATABILITY VARIANCE	.10921726E-01
REPEATABILITY STD. DEV.	.10450706
BETWEEN-LABORATORIES VARIANCE	.12714232E+00
BETWEEN-LABORATORIES STD. DEV.	.35657022
REPEATABILITY	.29575498
PERMISSIBLE TOLERANCE BETWEEN LABS	1.03053657
GRAND MEAN	50.40753247
VARIANCE OF THE GRAND MEAN	.50525492E-02

A.S.13

ISO/TC 183/WG 3A/WG 3A-5 COPPER IN COPPER CONC. SHORT IODIDE METHOD
SAMPLE: 85-10A

LABORATORY NO.	COUNTRY	BOTTLE NO.	ANALYTICAL RESULTS COPPER			LAB MEAN	LAB VARIANCE
1	LAB 2	1	28.4600	28.3900	28.4100	28.42000	.1300E-02
2	LAB 4	1	28.7800	28.6700	28.7100	28.72000	.3100E-02
3	LAB 6	1	28.5400	28.6100	28.6400	28.59667	.2633E-02
4	LAB 7	1	28.3750	28.4680	28.4290	28.42400	.2181E-02
5	LAB 8	1	28.5400	28.5260	28.5720	28.54600	.5560E-03
6	LAB 9	1	28.6110	28.5360	28.5730	28.57333	.1406E-02
7	LAB10	1	28.6870	28.7600	28.6880	28.71167	.1752E-02
8	LAB11	1	28.7370	28.6900	28.6990	28.70867	.6223E-03
9	LAB12	1	28.6550	28.8140	28.6960	28.72167	.6814E-02
10	LAB13	1	28.4300	28.3800	28.5300	28.44667	.5833E-02
11	LAB14	1	28.5500	28.4700	28.4500	28.49000	.2800E-02
12	LAB15	1	28.5500	28.5300	28.5600	28.54667	.2333E-03
13	LAB16	1	28.5900	28.5800	28.5200	28.56333	.1433E-02
14	LAB17	1	28.2800	28.3400	28.3400	28.32000	.1200E-02
15	LAB18	1	28.7000	28.7400	28.6200	28.68667	.3733E-02
16	LAB19	1	28.5260	28.4940	28.5580	28.52600	.1024E-02
17	LAB21	1	28.4600	28.5300	28.4900	28.49333	.1233E-02
18	LAB22	1	28.7780	28.6310	28.6310	28.68000	.7203E-02
19	LAB23	1	28.7100	28.7600	28.6500	28.70667	.3033E-02
20	LAB24	1	28.6800	28.7000	28.7400	28.70667	.9333E-03
21	LAB25	1	28.7300	28.7100	28.7100	28.71667	.1333E-03
22	LAB26	1	28.9500	28.8000	28.6900	28.81333	.1703E-01

A.S.14

ISO/TC 183/WG 3A/WG 3A-5 COPPER IN COPPER CONC. SHORT IODIDE METHOD
SAMPLE: 85-10A

BARTLETT'S TEST FOR HOMOGENEITY OF LABORATORY VARIANCE

CALCULATED STATISTIC	20.551
CHI-SQUARE(.95,21)	32.678

VARIANCE IS HOMOGENEOUS

DIXON'S TEST FOR LABORATORY MEANS

NONE REJECTED

LIST OF LABORATORIES WHOSE RESULTS WERE NOT USED FOR ONE-WAY ANOVA

ALL RESULTS WERE USED EXCEPT INDIVIDUAL REPLICATES LISTED BELOW

LIST OF INDIVIDUAL OUTLIERS DETECTED BY DIXON'S TEST WITHIN-LABORATORIES

NONE REJECTED

A.S.15

ISO/TC 183/WG 3A/WG 3A-5 COPPER IN COPPER CONC. SHORT IODIDE METHOD
SAMPLE: 85-10A

ONE-WAY ANALYSIS OF VARIANCE TABLE

SOURCE OF VARIATION	D.F.	SUM OF SQUARES	MEAN SQUARE
BETWEEN LABS	21	.10530958E+01	.50147417E-01
WITHIN LABS	44	.13238533E+00	.30087576E-02
TOTAL	65	.11854811E+01	

REPEATABILITY VARIANCE	.30087576E-02
REPEATABILITY STD. DEV.	.05485214
BETWEEN-LABORATORIES VARIANCE	.15712887E-01
BETWEEN-LABORATORIES STD. DEV.	.12535105
REPEATABILITY	.15523156
PERMISSIBLE TOLERANCE BETWEEN LABS	.37133725
GRAND MEAN	28.59627273
VARIANCE OF THE GRAND MEAN	.75980935E-03